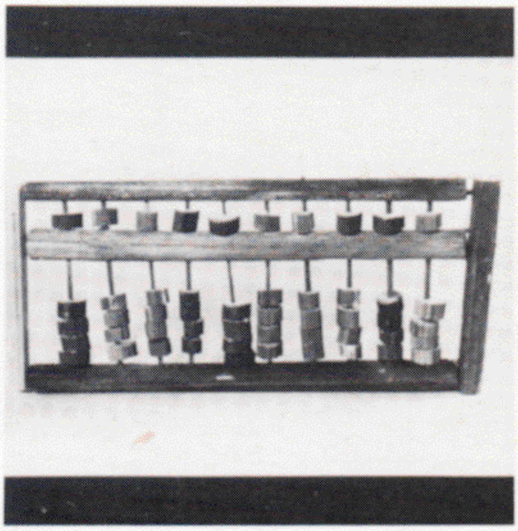
29
Document Series

Games and Toys in the Teaching of Science and Technology



Science and Technology Education

Division of Science Technical and Environmental Education

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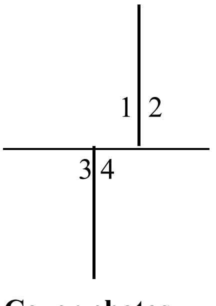

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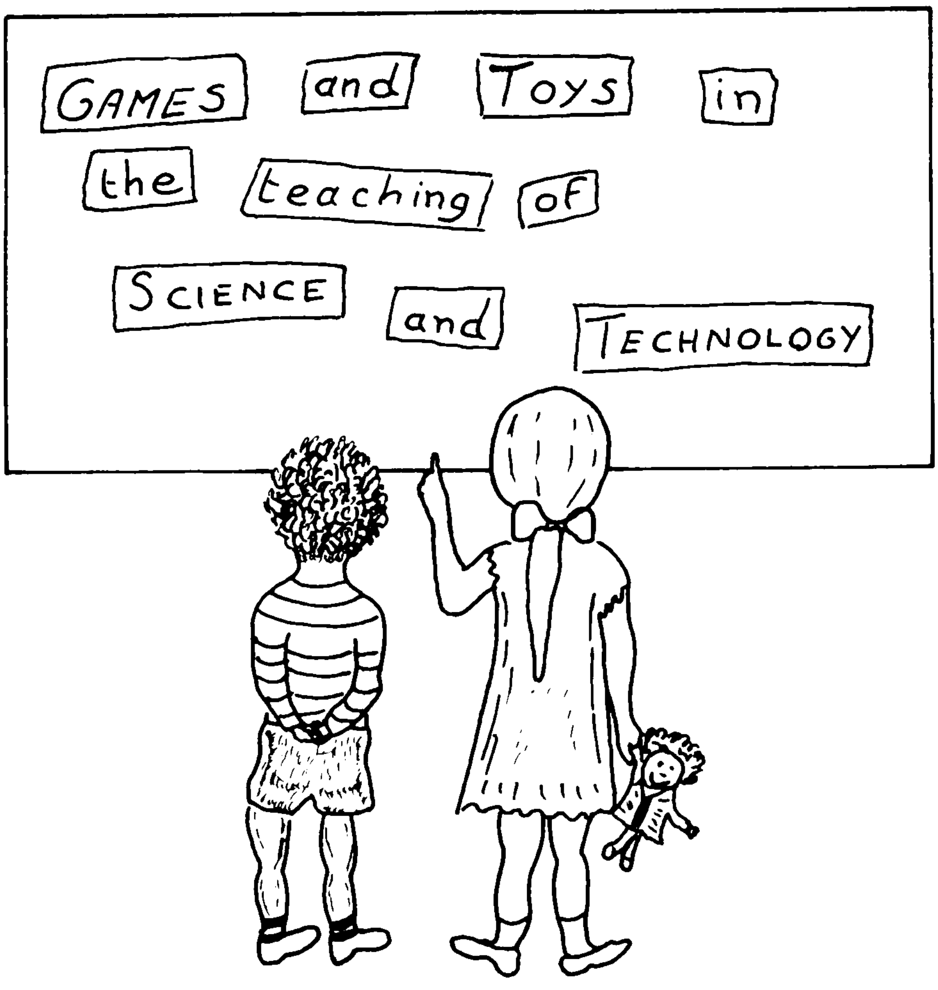


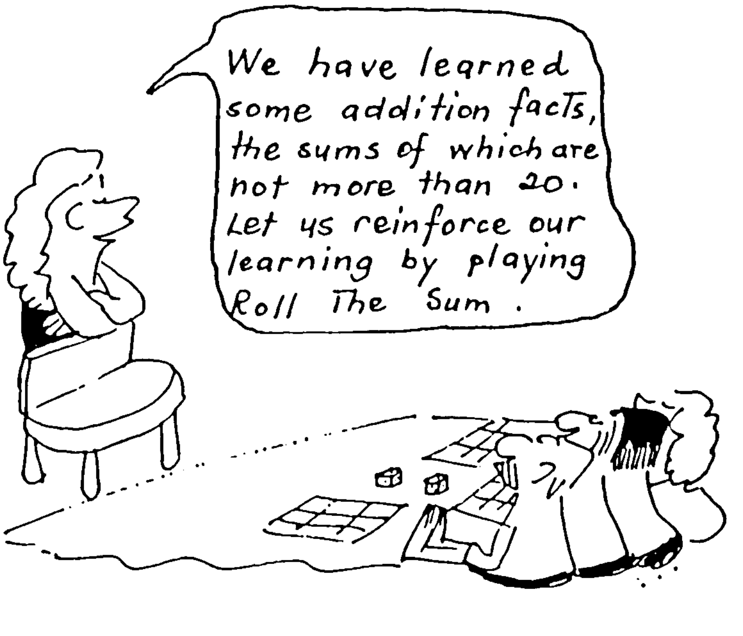
Edited by
Norman K. Lowe

A resource document on low cost educational activities for children in primary and early secondary levels of education

Division of Science Technical and Environmental Education

ED/88/WS/36 **UNESCO** Paris, 1988

There is no point in work unless it absorbs you
like an absorbing game if it doesn't absorb you
if its never any fun don't do it!
D. H. Lawrence.



PREFACE

This resource document has been prepared within the framework of Unesco's programme in the teaching of science and technology. In particular it is the outcome of a pilot project on *games and other experimental activities for the teaching of science to children.*

Toys and games play a large part in the early development of children, certainly in the more developed countries of the world. In such countries the commercial production of toys is in the league of big business. Toy Fairs are held, both national and international, and the range of toys and games cross international boundaries in their popularity. From the domestic point of view it is probable that, in a family with children, the festive seasons provide the greatest impetus to the giving and receiving of toys and games. This is by no means a new phenomenon. Archeological finds have indicated that toy making existed over 4000 years ago, and many of the toys used at that time are still being used today in one form or another.

Section 1 of this document sets the scene with regard to toys and games as well as to curriculum development trends and activities particularly at the primary level of education. In Section 2 examples of games and toys which can be used in the teaching of science and technology (as well as in many other disciplines) are detailed. These examples have been prepared from material obtained during the pilot project from Indonesia, Jamaica, New Caledonia, Niger, the Republic of Korea and Trinidad and Tobago as well as from the International Council of Associations for Science Education (ICASE).

Additional material has been included from a number of sources to which acknowledgement is given wherever used. Material submitted has, in some cases, been modified for the purposes of clarity of explanation.

This resource document has been compiled and edited by Norman K. Lowe.

The selection of material and the views expressed are those of the editor; they are not necessarily those of Unesco. In the event of an accident occurring through the use of any of the examples detailed, neither Unesco, nor the editor, nor the submitting countries can accept any responsibility.

Should you have a toy or game which may be suitable for publication in this series of documents, or elsewhere, please send it, with details of how to make and how you have used it in your teaching, to: The Director

Division of Science, Technical and Environmental Education
Unesco
7 place de Fontenoy
75700 Paris
France

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INTRODUCTION

Toys and games are synonymous with PLAY. Almost everyone likes to play and such a desire continues throughout an individuals life. Psychologists inform us that play is not just a filling in of an empty period, or just a relaxation or leisure activity, but it is an important learning experience. For example, babies play with their fingers and toes and in so doing bring about a social interaction with adults who join in their game with them. As the baby develops this same form of play is extended to assist the child towards numerary. The parent may often chant a rhyme such as

> one, two, three, four, five,
> once I caught a fish alive:
> six, seven, eight, nine, ten,
> then I let him go again.

whilst touching each of the child's toes. The basis here is towards assisting the child to learn to count.

Play is also seen as a means of working off aggression; as a means of learning basic skills of survival(as is also observable in the animal kingdom); as a means of learning social behaviour(competitive and co-operative games), as well as the commonly accepted means of relaxation.

In this modern age of computers, computer games have become a major software component. It is argued that children rapidly learn how to operate the computer through exposure to games since they are motivated to do so. If this argument is accepted then we have a concrete example of learning through play. In terms of technology, the additions available to the basic computers to extend their range is again a learning experience for children, who often wish to extend the range of their computer to perform more complex games. In stimulating the child through computer games we may see the benefit in the classroom and laboratory when the youngsters progress to learning science as specialisations in the later years of secondary education.

Although the majority of schools in the less developed countries are not likely to have computers in the foreseeable future the schoolchildren in these schools can enjoy their early experiences in learning science and technology through toys and games. For many, the only structured learning of science and technology is that which they will receive during their primary school education By introducing them to science and technology through familiar and enjoyable experiences their appetites may be whetted to continue their learning via out-of-school education programmes and thereby become more useful to the community as a whole.

This resource document is published so that teachers may be able to re-appraise their teaching approach and, where appropriate, incorporate some of the ideas contained in Section 2 into their teaching so as to create a more suitable learning environment for their pupils.

ACKNOWLEDGEMENT

Permission by the Estate of Mrs Frieda Lawrence Ravagli and Laurence Pollinger Ltd. to use the extract from the poem *Work by* D. H. Lawrence, is herewith acknowledged.

SECTION 1

Toys and Games - Are we all on the same wavelength?

In 1978, as a contribution to the International Year of the Child, Unesco and the Bernard van Leer Foundation held an exhibition of children's traditional toys and games which was first held in Unesco, Paris. Following on from this exhibition an international meeting was held in London, where a series of discussions took place on the theme of toys and games. In 1984 Unesco published *Toys and games of children of the world1.* The book is in two parts, the first an introductory essay on the cultural significance of toys and games, and the second part contains photographs from the exhibition.

Before attempting to consider toys and games in the teaching of science some observations id part one of the above mentioned book need consideration so as to place the ideas contained later in this document into context. The following are extracted from part one:

'What became apparent from the Unesco exhibition was that people in different cultures see toys, and to some extent games, very differently. . .

'Replies to the questionnaire seeking more information about toys and games revealed very different viewpoints. Much depended on the way work and leisure were related, on materials available for play, and on local ideas of childhood and practices of child rearing. . .

'Where factories, offices and schools sharply divided work from leisure, adults from children, and schoolchildren from infants, then most games and objects for play were also separated. Children's play objects were seen as toys, some with and some without educational significance: but toys were not associated with adult play activities. This meant that board games, which might be played by both, tended to be seen as toys if used for children's play, but as games if adults played. One way of making the difference was in the quality and cost of the materials. On the other hand, in rural conditions quite young children joined with adults in the tasks of making a living. Although play was reported, both adults and children taking part and making their own play objects, the existence of toys, as understood in the more industrialised countries, was very limited.

> 'Only man-made materials, however, seem to be viewed as toys. A toy is commonly thought of as exclusively a child's play object; furthermore, it may also be seen as something made by an adult for the child to play with. There is a difference between the child's own created objects of play and those given to him by others, whether they be mass-produced toys, frequently of doubtful taste and quality, or decorated, and often intricate, objects in clay, wood and textiles produced by skilled craftsmen. . .'

From these few observations we can see the difficulty when we are to consider toys and games and their role in science and technology education. Nevertheless, all is not lost. In educational circles around the world there is a greater cross-fertilization than in many other spheres of life. If we look at the school curriculum we see many similarities in the content being taught (although the methodology may differ). National Curriculum Development Centres incorporate in their curricula ideas from many countries, which they find appropriate to their requirements. It is perhaps therefore worth spending a little time in looking at the trends in primary and early secondary science and technology education.

The Curriculum in the Primary School

During the 1960s and early 1970s the major curriculum development activities in primary science were carried out in the United Kingdom and the United States of America. The Unesco publication New Trends ill Primary School Science Educatiosz2 indicates that the emphasis in both countries was towards child-centred inquiry and discovery learning. In the United Kingdom the early projects were concerned with providing teacher resource material allowing the teacher the greatest flexibility in achieving this end. The provision of pupil material was seen as being an inhibiting factor. By contrast, in the United States the new programmes developed a range of educational media including student books and workcards, and kits of apparatus, as an integral part of their material. In both countries, the later projects continued on the child-centred, hands-on, inquiry approach; within the United Kingdom projects turned their attention to producing pupil material in response to many requests from teachers, and in the United States the later projects developed student texts to accompany the teacher's editions as well as pupils activity books and record books.

During the 1970s curriculum development flourished in many of the developing countries. Initially, programmes produced elsewhere were adopted, but were often found wanting since they had been developed for a different cultural environment. Subsequently, national curriculum development activities have incorporated ideas and approaches from a range of externally produced programmes.

It is probably true to say that in all curriculum development projects at the primary and early secondary levels of education the lear)lislg by doing child-centred approach is uppermost. The New Trends publication was the follow up to a meeting of experts on the Incorporation of Primary Science and Technology in the Primary School Curriculum (Paris, June 1980). In the final report of the meeting the main arguments justifying the incorporation of science into the primary school curriculum were given as:

> 'science can help children to think in a logical way about everyday events and to solve simple practical problems. Such intellectual skills will be valuable to them wherever they live and whatever job they do;
>
> 'science, and its applications in technology, can help to improve the quality of peoples lives. Science and technology are socially useful activities with which we would expect young children to become familiar;
>
> 'as the world is increasingly becoming more scientifically and technologically orientated, it is important that future citizens should be equipped to live in it;
>
> 'science, well taught, can promote children's intellectual development;
>
> 'science can positively assist children in other subject areas, especially language and mathematics;
>
> 'primary school is terminal for many children in many countries and this is the only opportunity they may have to explore their environment logically and systematically;
>
> 'science in the primary school can be real fun. Children everywhere are intrigued by science problems, either contrived or real ones from the world around them. If science teaching can focus on such problems, exploring ways to capture children's interest, no subject can be more appealing or exciting to young children.'

This latter statement is, for the purposes of this document, the starting point.

'Science in the primary school can lie real fun'

We have to inculcate the idea that learning can be fun since our pupils are likely to have been conditioned to school being a place of hard work and no play. The teacher can do this by a careful analysis of his teaching methods. If our prime requisite in methodology is to progressively build on past knowledge then the new arrival in the school should commence his learning from the standpoint of his previous experience which, in many cases, will be toys and games, and most certainly so if the child has been fortunate enough to have been exposed to pre-school education such as a Kindergarten or play-group.

Whilst we are considering the curriculum the following extracts from an article in *Innovations in science and technology education*[3], published by Unesco in 1986 should further

assist us to place the role of toys and games in our teaching into clearer context, particularly if we consider the benefits to both science and technology.

The nature of science: process versus concepts

'A major issue in primary school science has been the relative emphasis upon *process* and *concepts*. Briefly, the case for the process view of science is that children should develop the mental skills and attitudes constituting a scientific approach in order to be able to investigate their surroundings and solve problems. These abilities, it is argued, enable children to respond to the changing world in whch they live, to reason logically and know how to seek and use evidence in all areas of their activity, not just in science.

The process skills to be developed have been variously described, but are usually taken to include observation, interpretations of observations and of data, inference, prediction, hypothesis, classification, communication, planning investigations (including the consideration of variables) and the combination of these and other process skills required to carry out investigations.

The associated attitudes (*of* science rather than *to* science) are generally taken to include respect for evidence, curiosity, critical reflection and sensitivity to living things and the environment. When processes and attitudes are considered the main focus, the role of specific content is generally played down; as long as the children approach a topic scientifically, it does not matter what the topic is, so the argument goes.

Underpinning the emphasis on process skills and attitudes there is an inductive view of learning science. It is assumed that gathering information by observation, and interpreting what is found, patterns and generalisations will emerge. Provided predictions from them survive testing, these generalizations add to children's conceptual knowledge of the world around them.

The alternative school of thought regards the teaching of scientific concepts as fundamental to the children's understanding of their world. The concepts concerned are generally included under headings such as properties of materials, forces, motion, energy and living things. In order to acquire these concepts, it is regarded as important for children to build up a coherent body of knowledge through encounters with specific content. Although these encounters involve them in using some process skills, the main focus is upon the product in terms of knowledge and concepts rather than the process of achieving this product. The underlying approach to learning is *deductive*; children learn the generalizations which they then use in understanding things around them. Primary school science programmes based on this view showed considerable similarities to secondary school science programmes and were to be found in many countries (such as Singapore and Indonesia) as a first response to science being included in the national syllabus before the wave of curriculum development began a few years later.'

In outlining the interaction of process and concepts in learning the article indicates that Recent classroom research (Osborne and Freyberg, 1985) shows that children often maintain *their own ideas* despite having been 'taught' ones which are more scientifically 'correct'. . .

> 'The best way to change childrens 'non-scientific' ideas, it is suggested, is to start from the ideas they already have and to help them to test out both their own and others' ideas, using evidence to decide which ideas are most useful for making sense of things around them. So the use of process skills is fundamental to the development of more acceptable and useful concepts. . .
>
> 'Children's ideas can similarly remain unchallenged unless an effort is made to ensure that their process skills are developed and freed from the grip of preconceived ideas. So children have to be encouraged to observe many different things about objects and events they study, to consider a wide range of variables, not just the ones they first think will be important, to search systematically for patterns and relationships and not merely those that their existing ideas or past experiences lead them to expect. In other words children have to be helped to approach problems inductively as well as deductively.
>
> 'The interdependence of process skills and concepts in learning means that the development of each has to be pursued simultaneously in children's science experiences. Activities designed to encourage process skill development in isolation from concept development (using 'empty' content such as black boxes or artificial problems) are as non-productive of useful learning as teaching scientific principles and generalisations by rote.

'Recognition of this is evident in the more recently produced curriculum materials in many countries. . . '

A further topic discussed is the continuity from primary to lower secondary school science education. The article indicates there is, in many countries, a marked discontinuity and lack of communication and that serious attention should be paid to improving the continuity between science in the primary and secondary levels of education. The article continues by saying

> 'As a first step, it may be useful to consider what is most appropriate for children to learn at each phase, using criteria which take into account the characteristics of the learner and the need for continuity. As an example, the following criteria were used in defining the basic concepts appropriate at the primary level in Indonesia. The concepts should be: within the grasp of children at their level of cognitive development, i.e. ones which children can construct for themselves; found in action in, and help the understanding of, everyday phenomena, i.e. ones which children can apply and strengthen through studying their immediate environment; accessible to children through the use of process skills; attainable through simple investigation, using equipment and materials available to the school, ones which form a basis for further science education (Harlen,1983).'

Although it is not intended that this resource document should deal in depth with the curriculum and methodology of learning, the foregoing outlines some of the trends in science education. Suffice to say that the progressive use of toys and games of increasing difficulty can be very useful, not only in introducing new topics, or integrating the curriculum in terms of the relevance of one topic to another, but also in developing some of the process skills referred to in conjunction with defined concepts.

The transition from the primary to the lower secondary level of education can also benefit from the use of toys and games particularly if coordinated to the learning that has taken place at the primary level. When considering technology(itself a process involving content from a number of disciplines) the wealth of understanding from the use of 'construction toys", which may already exist in the community or be developed locally from so-called scrap materials, is widely acknowledged.

In mentioning what can be developed locally, and before moving into Section 2 let us look at two projects which have been developed by curriculum development groups specifically with games in mind. By so doing we should be able to visualise the use of the examples in Section 2 in relation to our own teaching.

Games Project. A Physical Science Activity for Informal Learning

Lawrence Hall of Science - A Research Center in Science Education
University of California
Berkeley, California 94720
United States

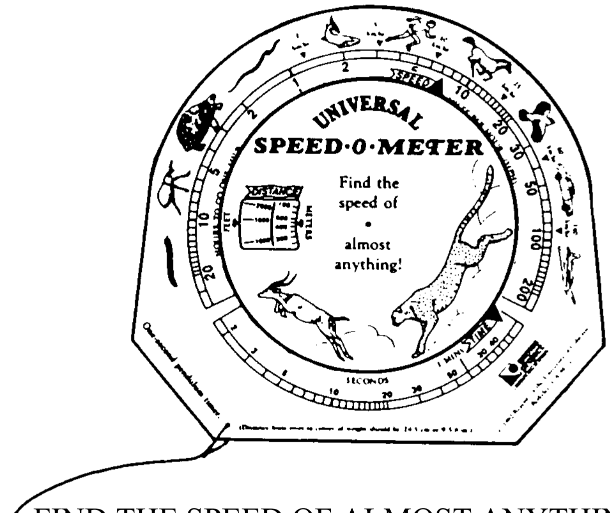
The following summary and examples of material developed indicate the approach used in developing and evaluating the project. Three of the games *(Limbericks, Speed-O-Meters* and *Sports Tip Cards)* may be purchased from The Discovery Center at the above address. Further information is available from Dr. Cary Sneider., Director of the Games Project, at the above address.

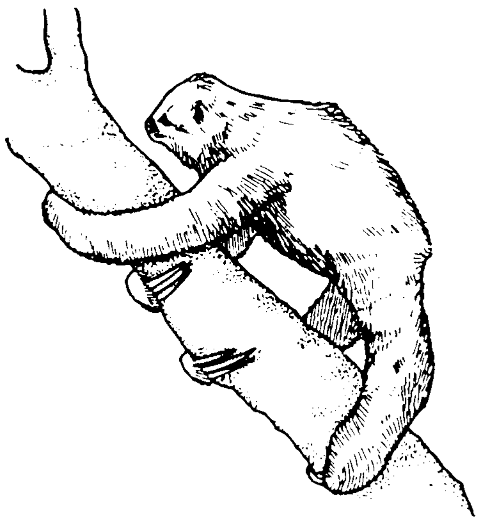
Summary

The purpose of this project was to examine the feasibility of developing physical science learning activities for informal learning settings outdoors and indoors. This was done through the development and testing of six sets of activities which are: appropriate for age 10 and above; self contained and complete; able to be used in one half to one hour; accessible to people with no background in science; usable by individuals or groups; compact; portable; and rugged.

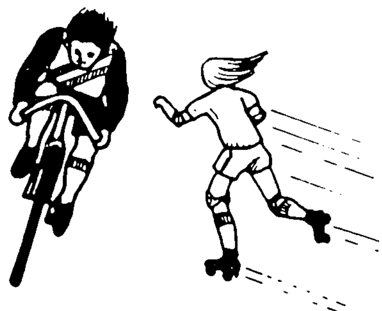
Over a period of three-and-one half years, seven sets of activities which met the above criteria were developed through formative evaluation: I) *Rubber Bones* teaches polar and rectangular coordinate graphing as a game of stretch and balance; 2) *Bompers* teaches students to read graphs and control variables through a game like kickball; *3) Sport Tip Cards* presents concepts such as momentum and simple machines in the form of tips to improve athletic performance; 4) *Limbericks* teaches concepts related to balance and perception through a set measurement, estimation and conversion of units through an attractive circular slide rule; 6) *Height-O-Meters* enable children to measure angles and use triangulation to compute distances; and 7) A *Question of Balance is* a game that communicates concepts related to centre of gravity and base of support.
The first six activities were subject to two forms of summative evaluation: a) pre-post tests of cognitive gains and user satisfaction and b) field observations by participant observers.

UNIVERSAL SPEED-O-METER





FIND THE SPEED OF ALMOST ANYTHING!



YOUR SPEED-O-METER MAKES IT EASY

A SPEED-O-METER is a simple cardboard device that allows a person to calculate the speed of almost anything from insects to race cars. Using a one-second pendulum timer and measuring tape provided in the activity packet, users can make all of the measurements themselves. The SPEED-O-METER then converts their measurements to speed in miles or kilometers per hour.

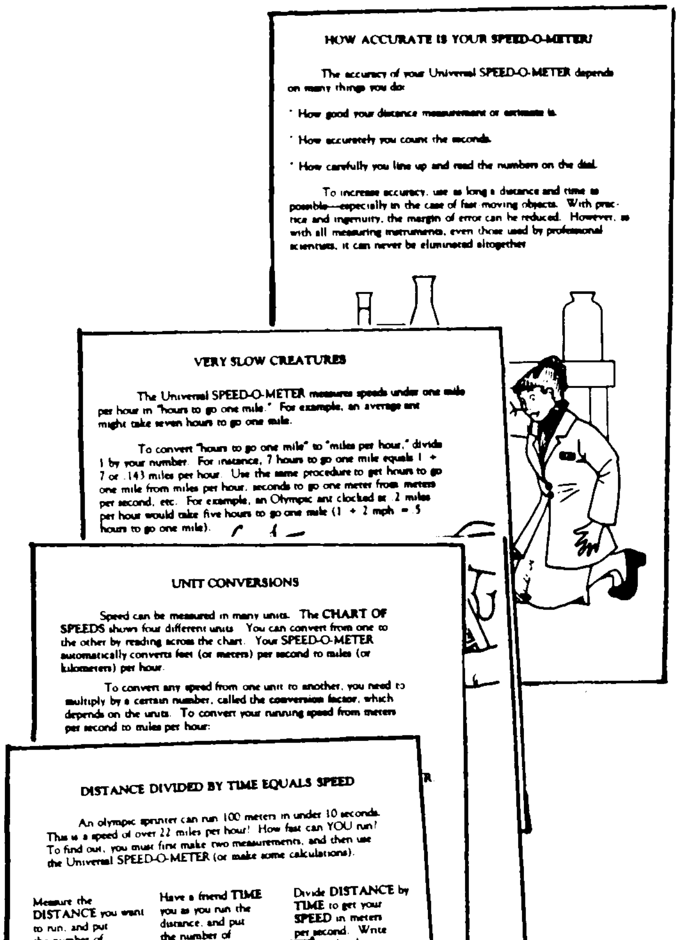
The SPEED-O-METER is actually a circular slide rule, though it is not necessary to know about slide rules to operate it. Just set the appropriate tabs on the time and distance scales, and read the speed. Younger users can find out how fast they run, or how fast they can throw a ball. Older users can take these activities as d starting point for understanding how speed is measured and calculated.

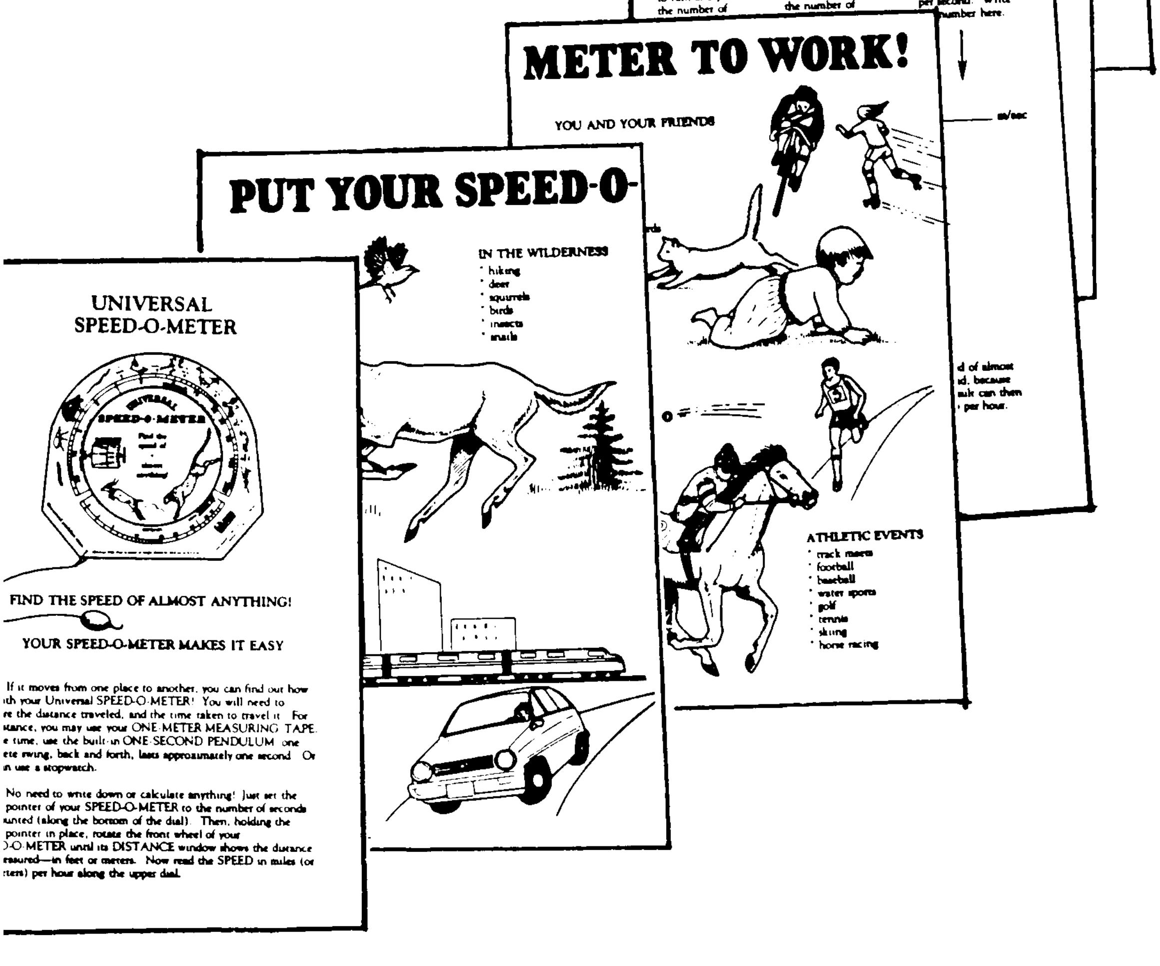
games project
LAWRENCE HALL OF SCIENCE

To assist the user in selecting interesting activities, an instruction booklet is provided in each packet. The booklet begins with an array of ideas for using the instrument, and proceeds to more detailed aspects including: how to calculate speed, how to convert units to miles or kilometers per hour, how to measure the speed of very slow creatures in "hours to go one mile" and how to estimate and improve accuracy.

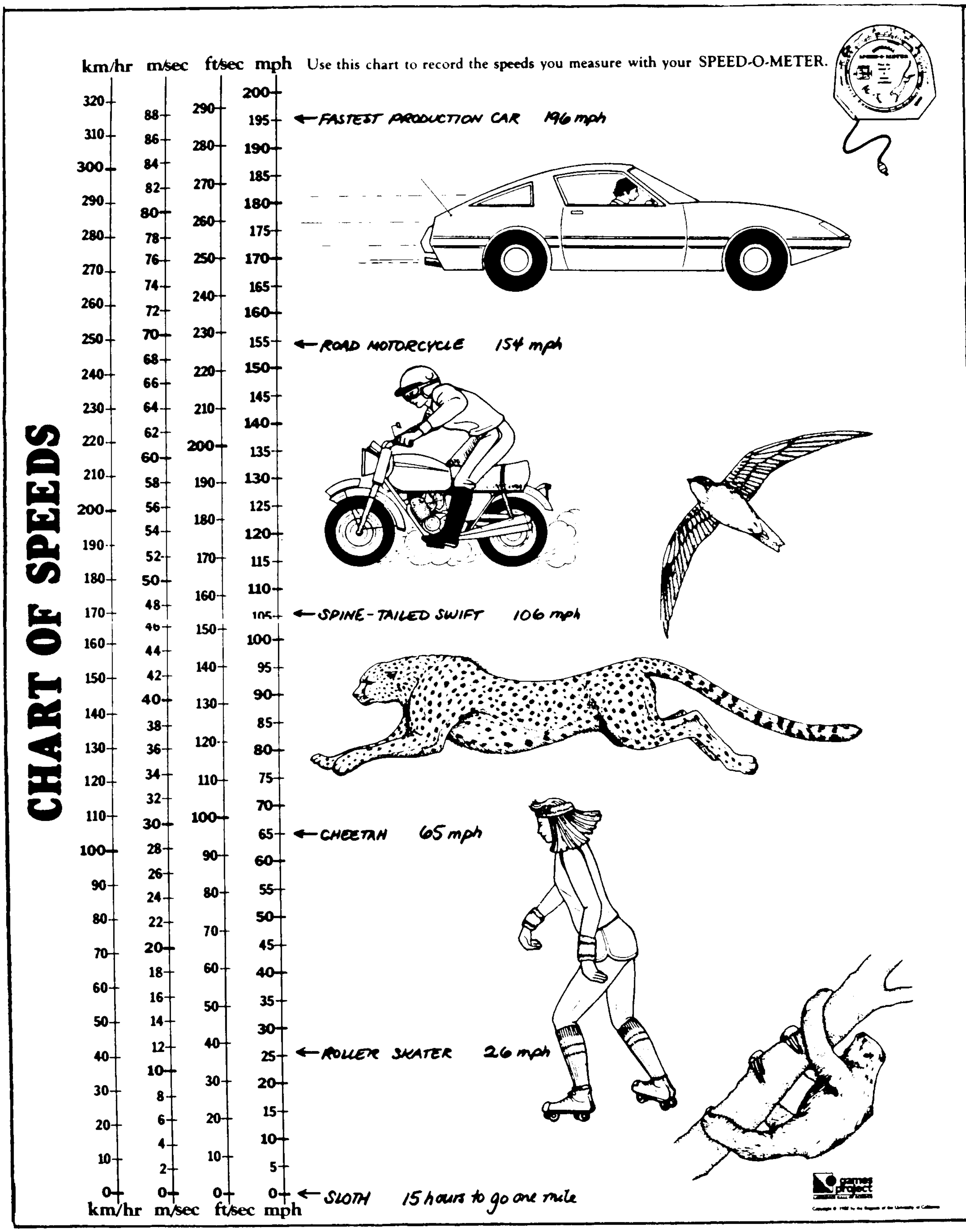
Also included in the SPEED-O-METER activity packet is a 17" X 22" poster showing the average speeds of a wide range of creatures and machines. The poster's scale is graduated in four units, side by side: km/hr, mi/hr, ft/sec, and m/sec. The poster allows users to see how these four scales are related, and to add the speeds they measure with their own equipment.

The SPEED-O-METER makes a compact, attractive shelf item that would be popular in state and national parks, science center stores, school supply houses, game stores, and a wide variety of other locations.





This 17" X 22" poster is included in the SPEED-O-METER kit.



Can you do these... *LIMBERICKS?*

15 different action-packed *POSTCARDS* ...Challenge your friends!

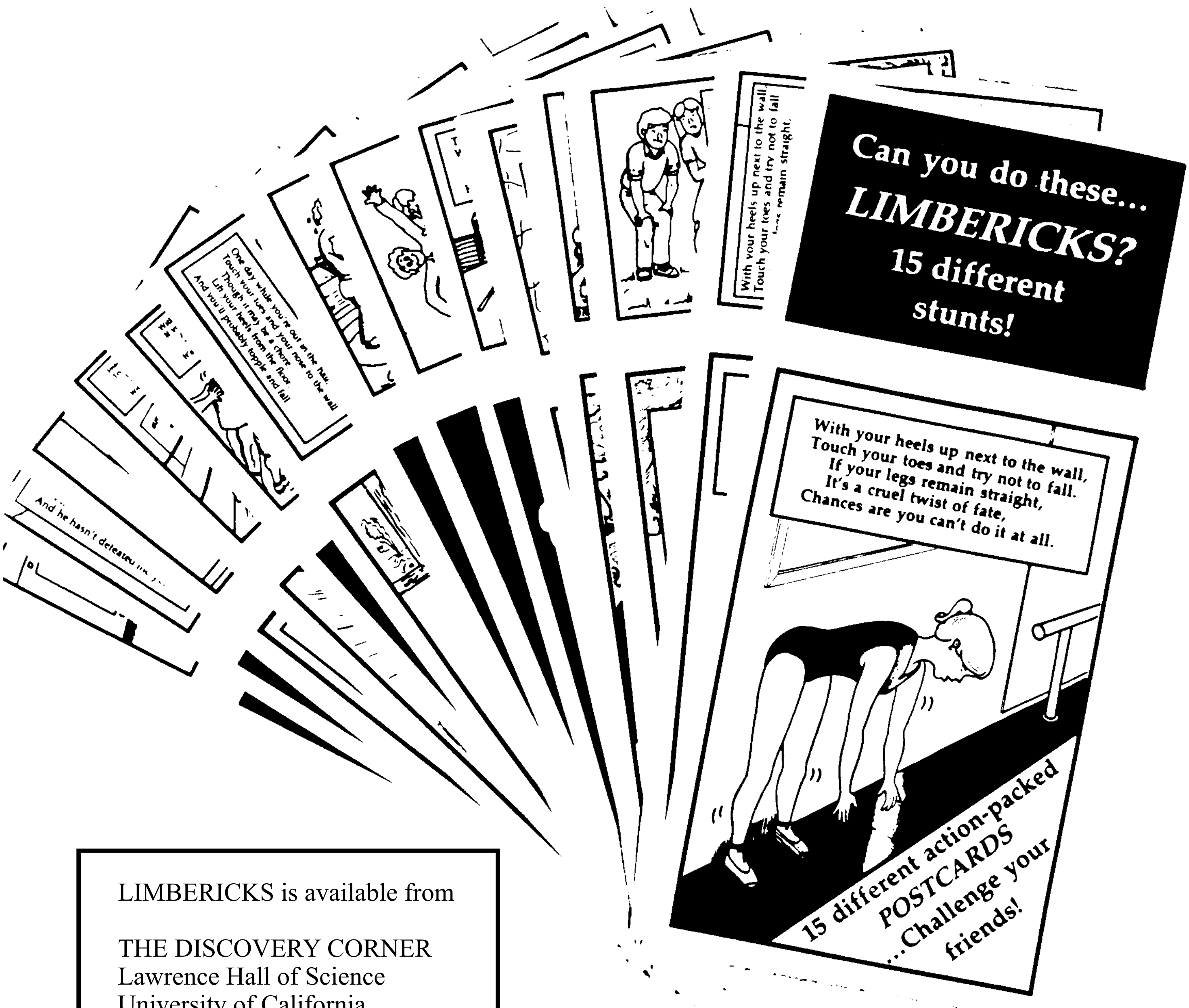
Here's a trick using only one eye:
Touch the ends of two sticks with one try.
Though you won't miss by much,
The ends just won't touch.
Use both eyes and it's easy as pie.

Your ability to see how far or close something is requires both eyes working together.

LIMBERICKS is a booklet of fifteen attractive, cartoon-style postcards. Drawings challenge the user to perform body stunts that look easy, but are really tough to accomplish. Others look difficult but turn out to be easy!

Each LIMBERICKS stunt evokes surprise and curiosity which can be satisfied by turning over the card to see the scientific explanation printed on the back. Science concepts include: center of gravity and base of support, weight distribution, depth perception, use of levers, movement of muscles and tendons, recoil, free fall, vertical and horizontal force components

games project
LAWRENCE HALL OF SCIENCE



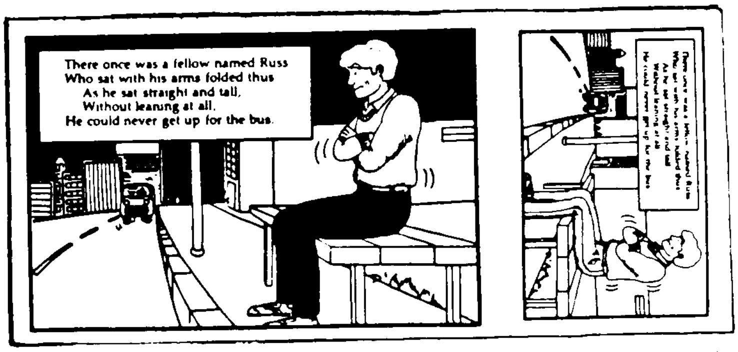
LIMBERICKS is available from

THE DISCOVERY CORNER
Lawrence Hall of Science
University of California
Berkelev. CA 94720

for $1,95 each

If your center of gravity, or balance point, is not over your base of support (the area enclosed by your feet), you will

The LIMBERICKS package allows the user to tear off each postcard as it is needed, and leaves the sender with a record of each cartoon, and each scientific explanation. The package would make an ideal item for sale at summer camps, state and national parks, schools, science center stores, and wherever postcards are sold. Preliminary editions are printed in two colors, but commercial publishers would be able to use a full color process to make the cards even more attractive.



Russ's center of gravity (balance point) is over the seat. Unless he shifts his weight forward so his center of gravity is over the area enclosed by his feet, he will not be able to stand up.

A Nigerian Experience

The second example is from Nigerian It is all extract from all article primed in the CASTME JOUR - NAL Volume 5, Number 1, 1984 entitled *Integrating Traditional* ***games*** *and play activities into pri - mary science education programmmes]* and is a report on a project undertaken by Dr. Eunice A. C. Okeke, Senior Lecturer and Co-ordinator, Sub-Department of Science Education, University of Nigeria, Nsukka.

The abstract of the report commences with a resume of international and national educational researchers on curriculum development. It outlines the curriculum development activities in Nigeria and indicates that, in spite of these activities at home and elsewhere, fewer and fewer people enrol for the basic sciences. The Abstract continues

'Okeke (1983) in discussing how home can act as supportive agents to science education of children drew attention to the potentials for science teaching in common home activities. Opportunities abound in children,s out-of-school activities, in which desirable science skills, such as counting, measuring, observing, comparing, and inferring, can be acquired.

Thus, situations where pupils can learn while having fun have to be explored and utilised. The technologically advanced countries have recognised this, and use simulation games extensively. Lots of these have been developed on the lines of indoor games their children engage in, such as cards, dominoes, etc. In Nigeria, there are several plays and games that can be adapted or utilised for making science fun and overtly relevant and meaningful to children. Shuaibu (1983) described some of these games. In the study reprinted here, no such distinction is drawn, for children scarcely recognise the distinction. For them and for the teacher games or plays are fun, and the activities have potentials for acquisition of desirable cognitive, affective and psychomotor behaviours in science. This study, therefore, aims at

I) collecting and describing some popular games and play activities that Igbo children engage in;
2) analysing these activities to identify science-related cognitive, affective and psychomotor behaviours in them; and
3) illustrating how a primary science teacher can profitably utilize such games to achieve some of the objectives in the current Federal Government Core Curriculum in Primary Science.

Procedure

To meet the first objective the researcher visited a number of primary schools, playgrounds and homes both in urban and in rural areas in the Igbo-speaking parts of Nigeria. By this process, it was possible to record on the spot the type of games and plays that children engage in. Some play activities were noted to be more popular than others. Altogether some 15 most commonly occuring play activities were listed. each of them was described with the help of the children themselves, noting the activities that were rule-governed and those without rules.

In pursuance of the second objective, the researcher prepared a questionnaire. It contained the described play activities and required respondents to indicate what cognitive behaviours, skills and attitudes related to science were contained in each activity. The respondents were science teachers (thirty in number), to include those who teach chemistry or biology or physics or integrated science. They were given a long time to study and to become familiar with she play activities, to enable them to do a critical analysis of each, and to identify the associated science concepts, skills and attitude. Their responses were examined and a comprehensive list compiled of behavioural attributes associated with each play activity. The games/plays that had much to offer for science teaching with special reference to the core curriculum for primary science were noted and discussed under findings.

The Findings directed the researcher in making concrete suggestions, with vivid illustrations drawn from the core curriculum, on how traditional out-of-school activities children engage in can create opportunity for science that can be applied in solving our problems within our environment (see Table 1).'

Table I listed 15 activities which had been identified during the project. The first five of these activities are shown in Table 1. The article continues -

'Findings and Discussion

'Table 1 clearly indicates the science concepts and ideas that are associated with the listed play activities. These include properties of objects, combination, states of matter, heat and energy, conduction, mixtures, leaves, air, pressure, shapes and sizes, elasticity, wave formation, work, acceleration, friction and surfaces, sound transmission, sound waves, pitch, living things, buoyancy, levers, etc. These topics are also found in one form or another in the specified content of the Federal Government Core Curriculum. For example, included in the content area are: using senses for seeing, hearing, touching, etc.; properties of air, wind, classification of objects, water, evaporation, condensation, measurement and ordering of volumes, weights, lengths, making sound, heat, temperature, energy, human body, bones, joints, movement and breathing, air pressure, soaps and alkalis, pulley, levers, friction, force, etc. Therefore there is a close resemblence between the content of the core curriculum and those identified by science teachers as being derivable from traditional games/play activities.

'The core curriculum apart from prescribed content has a list of objectives to be achieved using the stated subject matter. These objectives include that pupils

- observe and explore the environment,
- develop basic science process skills: including observing, manipulating, communicating, inferring/hypothesising, interpreting and formulating models.
- develop a functional knowledge of science concepts and principles.
- explain simple natural phenomena.
- develop a scientific attitude: including curiosity, critical reflection and objectivity.
- apply skills and knowledge gained through science to solving everyday problems in the environment.
- develop self-confidence and self-reliance through problem solving activities in science; and
- develop a functional awareness and sensitivity to the orderliness and beauty in nature.

'While it is expected that the primary science teacher will adopt teaching strategies that will enable her pupils to attain the objectives, the use of games and play activities may not overtly show how they can contribute to the achievement of the stated objective. Table 1. has listed identified science process skills and attitudinal behaviours that can be tapped in the course of engaging pupils in play activities. These process skills include measurement of lengths, weight and angles, observation, classification, manipulation, comparison, estimation, organisation, communication, hypothesising, predicting, experimentation, discrimination, co-ordination, alertness, recognition, etc. The attitudinal behaviours that can be developed in the course of playing these games include objectivity, creativity, imagination, cooperation, healthy competition, aesthetics, open mindedness, etc.

'It is evident that the games and plays of children in Igbo culture have entrenched in the majority, if not all, the science processes and skills which teachers of primary science emphasise. All that is required is that primary science teachers and curriculum developers recognise this.'

The article continues by discussing some of the activities which had been observed to illustrate the fact that traditional Igbo games and play activities can be harnessed to teach basic scientific concepts and process skills as well as accepted scientific behaviour. It further argues that when teaching science we should not just refer to traditional games or activities as an embellishment to the topic but that these 'embellishments' should themselves be the core from which the topic should be developed.

In concluding this section the following extract from Dr.Okeke's paper should help to make us more determined to re-appraise our teaching methods and utilise and develop the examples and ideas portrayed in section 2.

'If only the teacher would recognise that there are three stages in the introduction of science (Presst 1980), and she can, at the primary school level, limit herself to the first two stages - the first stage involving simple process skills such as observing, recording, comparing, describing, investigating, etc., and the second stage interpreting and predicting; stage three involves controlling variables and is to be left until pupils are intellectually mature for hypothetico-deductive thinking. In fact, it is the misconception that science has to be purposeful experimenting that debars science teaching from introducing more enriching learning experiences. Games and play activities have been shown (De Cries and Edwardws 1.973) to have the potential for organising meaningful learning experiences.

Table 1. Selected games and associated cognitive, affective and psychomotor behaviours

Description of games/play activity.	Associated scientific/ concepts & themes.	Science skills & processes.	Affective Behaviour.
Children construct houses with sand, sticks, leaves etc.	Building of models; properties of objects e.g. resilience, weight.	Measurement of length, size, angle, space. Estimation, prediction, observation & manipulation: ation. classification.	Interest, curiosity, experimenting, appreciation
Cooking leaves sand in cans with playmates imitating mothers in kitchen chores.	Combustion support: oxygen change in states of matter. Temperature changes, heat/ energy transfer & conduction, physical mixtures, chemical reaction Properties of leaves.	Measurement, observation, making inferences, classification.	Creating co-operation.
Blowing balloons of different sizes, shapes and make.	Shapes and sizes, principles, of expansion, elasticity, pressure changes, volume of gas and air.	Manipulation blowing, comparison, observation.	Trial and error.
Pulling with strings, objects termed goat, cow, etc.	Force, friction, motion, mass, or weight of object.	Comparison, classification, observation.	Imagination.
Throwing stones in stagnant water.	Ripples/wave formation, wave motion, wave length, pressure, work energy conversion.	Observation.	Curiosity.

While many teachers and curriculum planners may want to introduce play activities in primary science, there is still the fear of external examinations and award of certificates. Surely this ever-recurring issue has killed several well-meaning innovations. This will continue for as long as we view education as a selection instrument and a prestige-conferring device. This explains why all learning has been ritualised, curiosity devalued and no inquiries about the usefulness, the relevance or the interestingness of what is learned (Dore 1976).

Perhaps the introduction of continuous assessment creates room for innovations in the teaching and learning of science, whereby teachers can build their science lessons, especially at

the primary school level, around traditional games and play activities pupils love. 'The neglect of cultural activities' Thijs (1983) emphasised, 'is an important reason for the alienation of people from science'. Science must be humanised and the primacy of societal goals and values emphasised. In describing and advocating the use of games in teaching science, we need to remind ourselves that, 'when a person interacts with a part of the world in some way, he doesn't just learn that little piece of information is the result of interaction, he also learns how to interact with the world. . . When children play, they learn generally how to play. So in order to have intelligence develop, it is necessary to have lots of experiences, lots of active engagement and especially to have varieties of experience. . . The child must be given many opportunities to use the things that he likes to do naturally, as tools for developing new skills and abilities.(Ohuche 1979).

'Traditional games and play have the potential for meaningful science education and they must be harnessed.'

The above two examples indicate two alternative approaches to games in the teaching of science. The Games Project from the United States outlines the development of new games to meet educational objectives. The Nigerian Project outlined a study on traditional games and play activities and their use in a Core Curriculum to meet educational objectives.

Individually, or collectively, teachers should utilise both approaches to incorporate into their teaching *learning from the environment and the familiar so* that their pupils can successfully progress from the familiar to the abstract using a process based on understanding, compared to a rote learning approach producing 'tunnel vision'.

Section 2 contains examples of games and toys which can, and are, used in the classroom and are easy to make. Let us have a look at these and on the way enjoy ourselves by

PLAYING GAMES

References

1. Chanan, hi; Francis, H. 1984. *Toys and Games of Children of the World.* Paris, Unesco.
2. Harlen, W. (ed.). 1983. *New trends in primary school science education.* Paris, Unesco.
3. Harlen, W. 1986. Recent developments in primary and lower secondary school science. In: D. Layton (ed.), *Innovations in science and technology education.* Vol.l. Paris, Unesco.
4. Okeke, E. A. 1984. Integrating traditional games and play activities into primary science education programmes. In: *Commonwealth Association of Science Technology and Mathematics Educators Journal.* Vol. 5, No. 1. pp. 1-15.

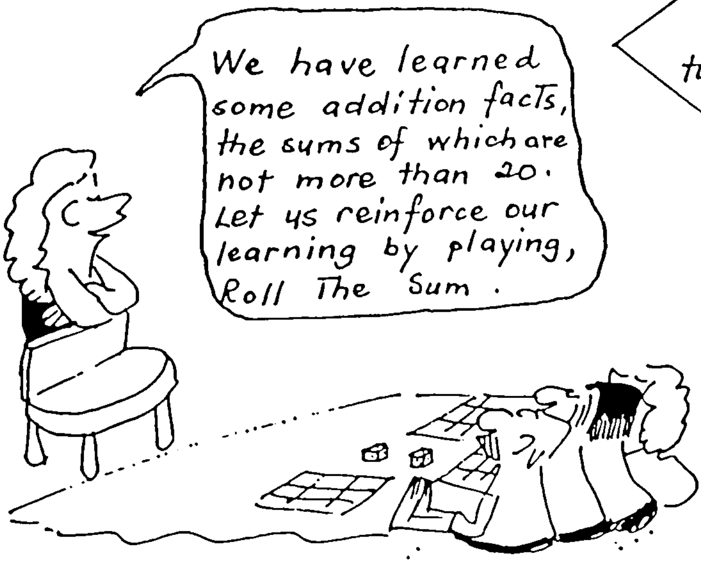
SECTION 2

Examples of games and toys which can be used

in the teaching of science and technology

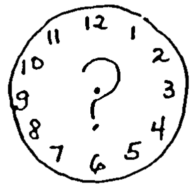
Some principles that the teacher might consider in using games in the classroom.

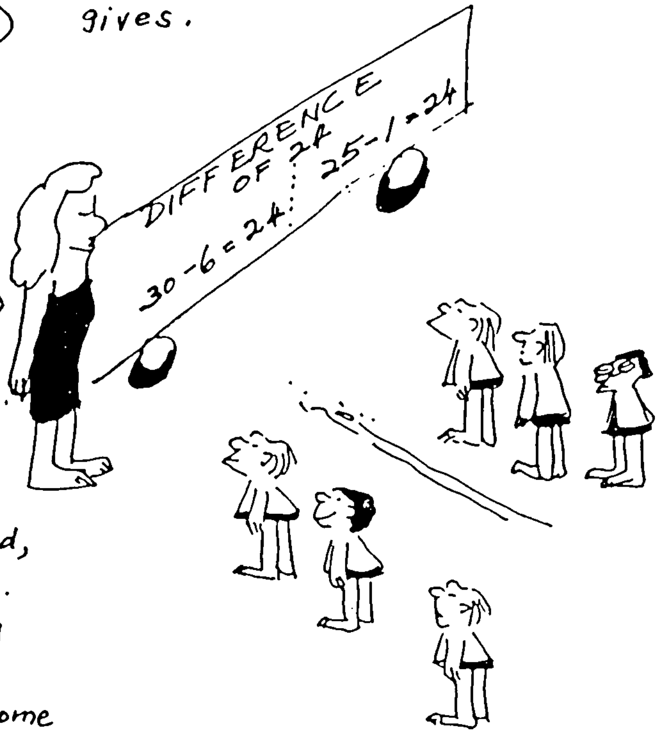
Select the game according to the needs of the class.



The game should make a unique contribution to learning. It should be a part of the regular class-work. Learning should be stressed and of course the pleasure that the game gives.

Use the game at the proper time.





Games should be used at the time when ideas or skills are being taught or reviewed, others after completing a topic. Some teachers use games during days of heavy absence due to storms, concerts or excursions. Some use them as rewards for work well done. Others use them as remedial work. Games should be played relatively short so that pupils do not lose interest.

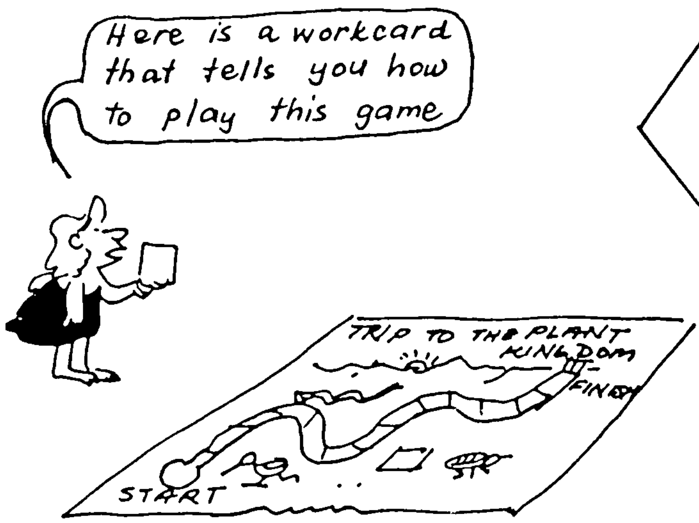
Arrange the game situation so that all pupils will be able to participate.

In playing games see to it that everybody participates. Embarassment should be avoided on the part of the player who cannot solve the problem at once or one who cannot get the rule at once.

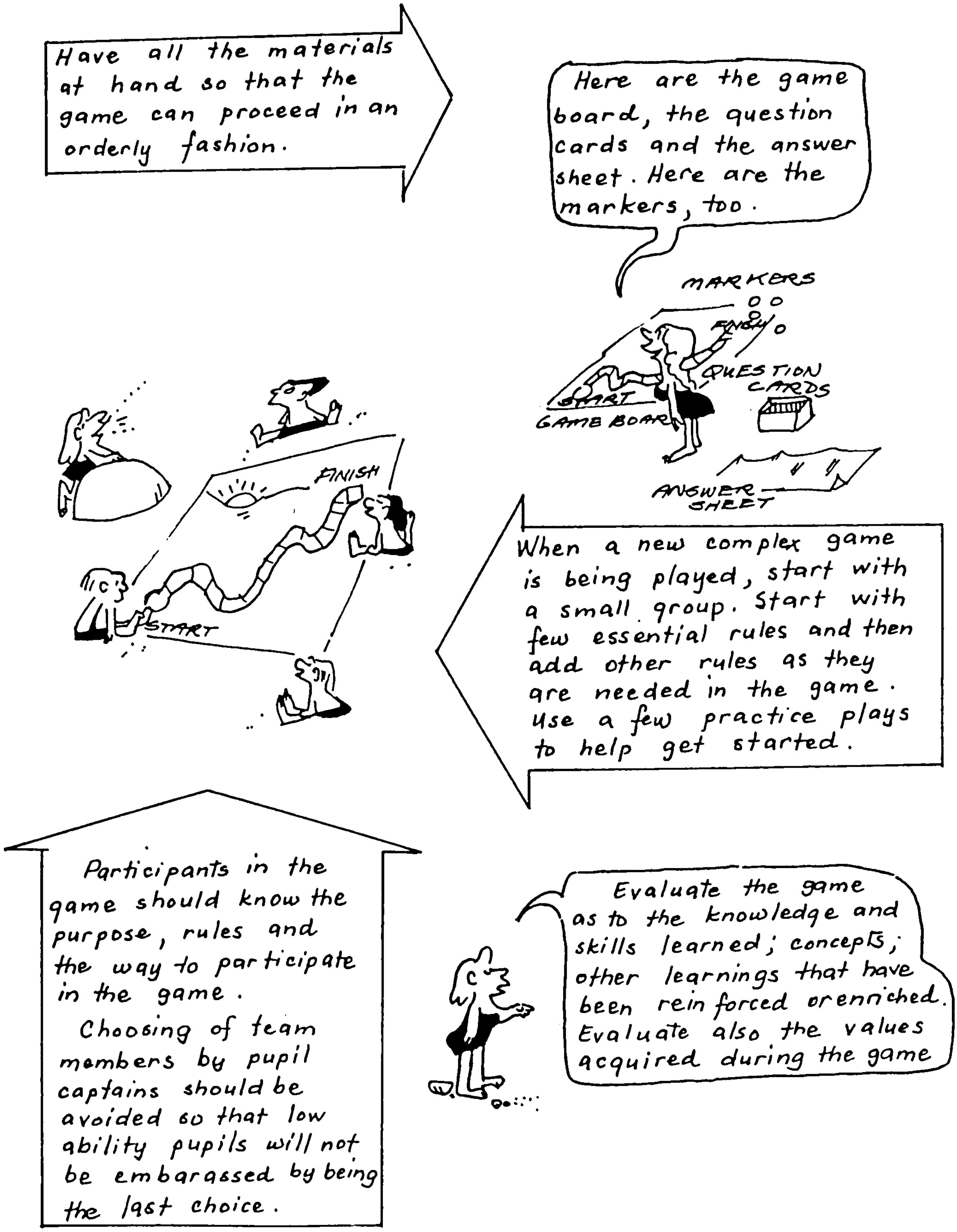
As much as possible the game leader, if there is one should give positive comments. Good works should be commended.

Whenever possible pupils should work / play on materials suited to their ability.

PLAN AND ORGANIZE THE GAME CAREFULLY SO THAT THE INFORMALITY AND EXCITEMENT OF SETTING DO NOT DEFEAT THE PURPOSE.



Teach the playing of the game in a planned organized way.



The above working principles are extracted from a publication Games for Primary Science and Mathematics submitted by the regional Centre for Education in Science and Mathematics (RECSAM), Glucor, Penang, Malaysia

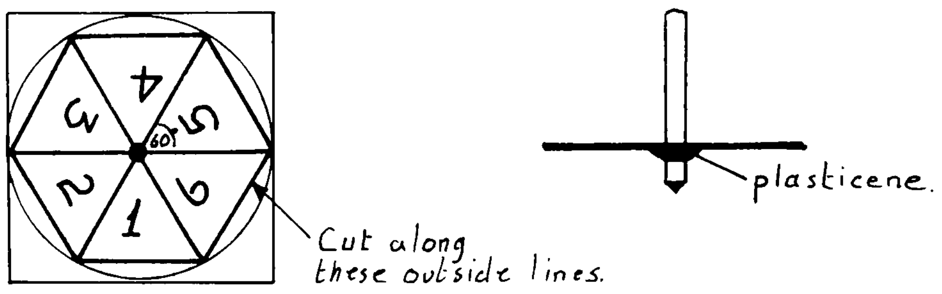
How to make a spinner for use with board games

Materials needed

Stiff Cardboard approximately 4cm square; toothpick or short pencil or old ball point pen; coloured pencils or pens; plasticene; glue; scissors; drawing compass; 30/60 set square; rule.

Construction details

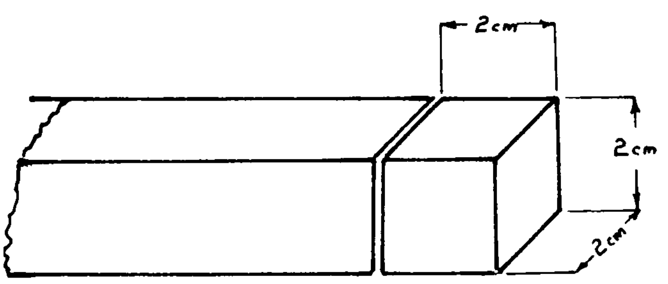
Lightly mark the centre of the square. Set the compass to draw a circle of 2cm radius and draw the circle from the centre of the square. Using the 60 set square divide the circle into six equal parts. At the circumference draw straight. lines between each intersection as shown in the sketch below, and number each sector.
Push a toothpick through the centre of the disc for a distance of approximately 1 cm. and fix in place using some plasticine on the underside of the disc as shown in the sketch below. If using a pencil or ball point pen cut them to a suitable length. Make a hole at the centre of the disc and glue the disc to the pencil or pen as shown. If needed add some plasticine to provide a firmer fixture (and also to add a little mass to the spinner to assist spinning). Ensure that the plasticene is even all the way round so as to avoid an out-of-balance spin giving a preferential number each time the spinner comes to rest.

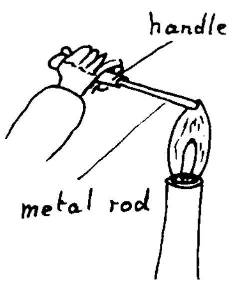


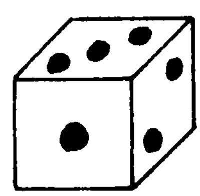
How to make a Die (Dice)

Obtain a square piece of wood approximately 2cm x 2cm. Very carefully cut a 2cm length from this wood to form a 2cm cube. Heat a steel or iron nail and burn indents into each face of the cube to act as the numbers - the face with one indent should be opposite to the face with six indents; the face with two indents should be opposite the face with five indents; and the face with three indents should be opposite the face with four indents.
Care should be taken when making dice so that one face is not 'loaded', which would cause one of the numbers to occur more often in preference to others.

(A good statistics game could be developed from this!)







Snakes & Ladders

Snakes and Ladders is a popular game for children in many countries of the world. It is easy to make from basic materials and can be adapted to suit many learning situations.

Educational Concept/Skill to be developed

Of great importance in any game are the Rules. Not only are these the How-to-Play instructions but they are the boundaries in which the game can be played. In educational terms the rules equate to 'devising and planning investigations' which is one of our process skill objectives. In addition, snakes and ladders can assist in developing basic arithmetic such as counting, addition and subtraction, communication, as well as the concept for which a game has been developed such as Nutrition, Health Education, etc. as shown in the examples given.

Points for the teacher to consider

The basic rules for snakes and ladders are as follows but these can be varied according to the educational use of the game as shown in the Nutrition Snakes and Ladders example.

Rules

Two, three or four people may play.
Each player throws the die Or Spins the spinner.
The player who has the highest number starts the game by throwing the die and moving his/her counter, starting at space 1, according to the number shown on the die or spinner.
If a player scores a six, he/she throws the die or spins the spinner again.
If a counter stops on the head of a snake the player must slide the counter down the snake until it gets to the tail, then carries on from that point. If a counter lands at the foot of a ladder the player moves it to the top and carries on from there.
The first player to reach the square which has the highest number on it is the winner.

Nutrition Snakes and Ladders

How to play the game

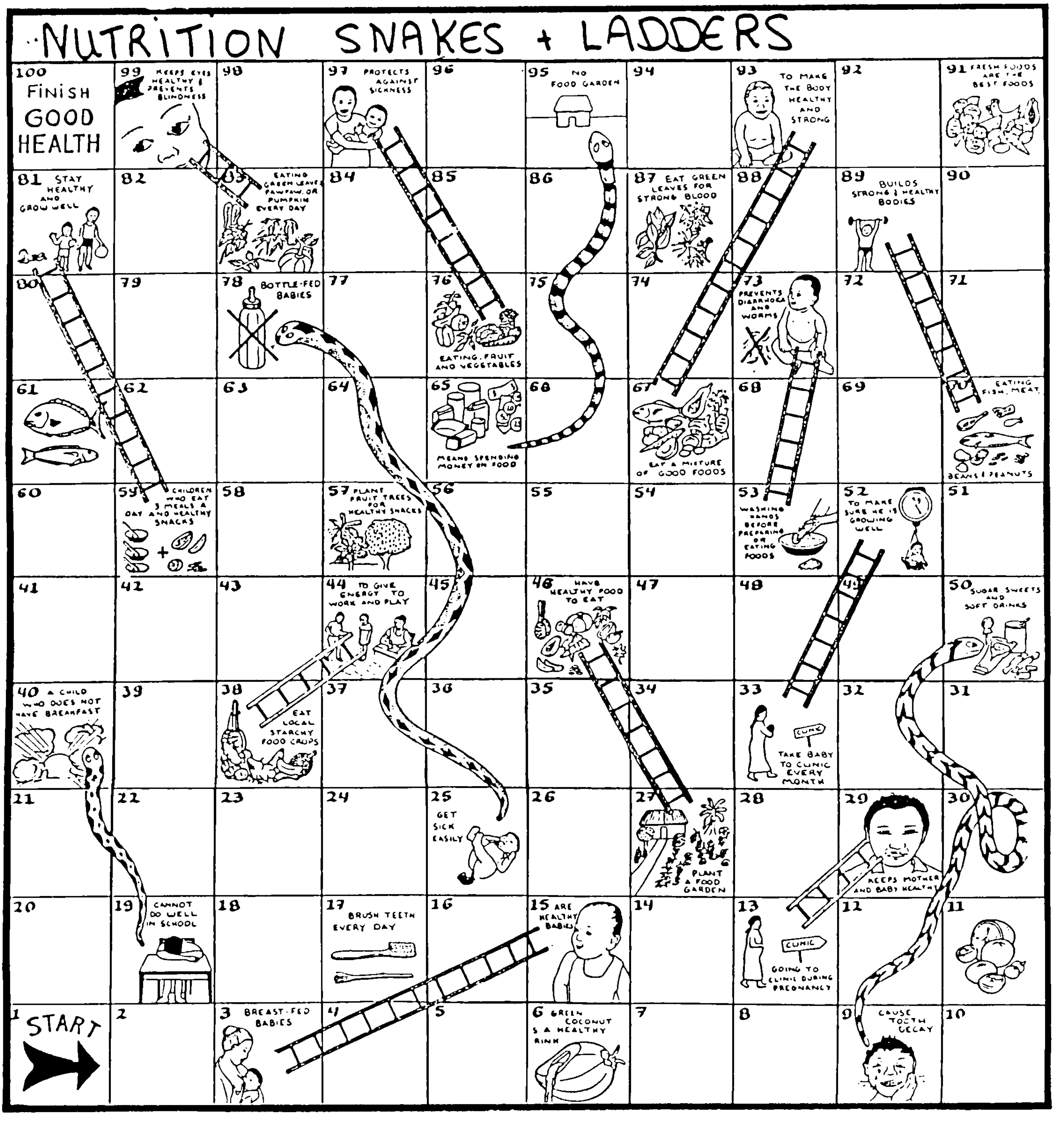
1. The game can be played by two or more players up to a maximum of 6 - 8.
2. Each player should have their own marker (counter). Different shaped shells or stones, or coloured pieces of paper or plastic, or bottle tops, make good markers. Each player starts with their marker on square 1, marked START, which is at the bottom left hand corner of the board.
3. To decide who goes first, each player must shake the die or spin the spinner; the first player to get a six starts the game. He/she then throws again and moves their marker forward the number of squares indicated on the die or spinner (ie. 1,2,3,4,5 or 6 squares). Play then continues with the player on the left of the starter throwing the die or spinning the spinner and moving his marker, and so on. Players play in the same order until someone reaches square 100, which is the Finish or GOOD HEALTH square.
4. a) If a player lands on a square at the bottom of a Ladder, they must read out the message written on the square, move their marker up the ladder and finish reading the message at the top of the ladder. The players should discuss the meaning of the message.
   - is the message describing a good nutrition practice or a poor nutrition practice? (Ladders should describe good messages).
   - is the school/family/community practising these good nutrition messages?

   When a player has gone up a ladder, they can continue playing from the square at the top of the ladder. The good nutrition message will have helped them move faster up the board to finish with GOOD HEALTH.

   b) If a player lands on a square with a snakes head on it, they must read out the message written on the square, move their marker down the snake and finish reading the message at the bottom of the snake. The player should discuss the meaning of the message.
   - is the message describing a good nutrition practice or a poor nutrition practice? (Snakes describe bad messages).
   - how can these poor nutrition practices be prevented from occurring in the family/school/community?

   When a player has gone down a snake, they must continue playing from the square at the bottom of the snake. The poor nutrition message will have slowed the player down so that he/she moves more slowly towards the finish and GOOD HEALTH.

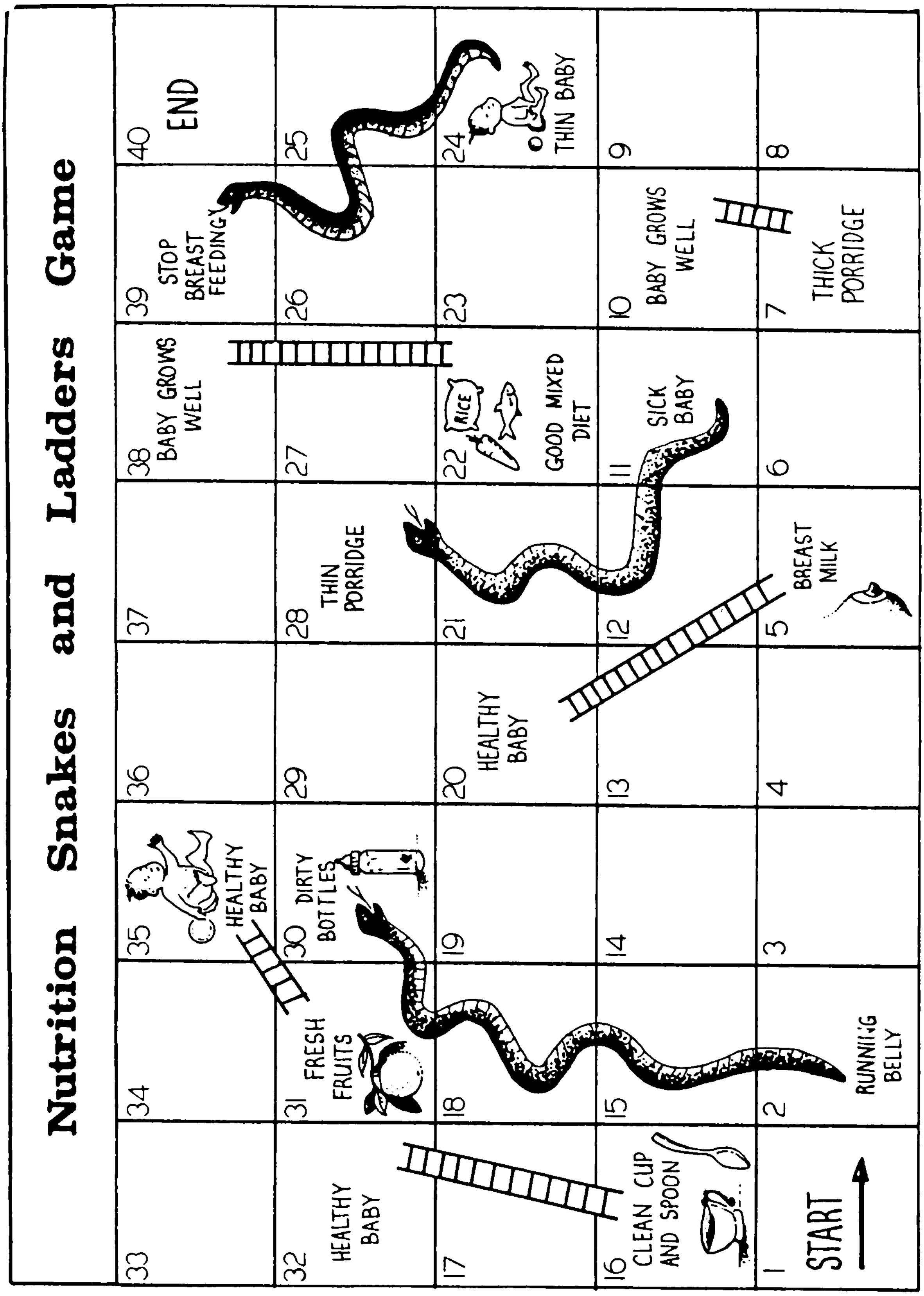
   c) There are some squares with good nutrition messages on but no snakes or ladders. When a player lands on these squares, they leave their marker in the same square and discuss the message written.
5. The first player to reach the finish square is the winner of GOOD HEALTH. All players must remember to practise the good nutrition messages so that they will stay healthy.



This Nutrition Education Game has been developed, and a pilot version used, in schools and in community education programmes in a number of countries in the South Pacific. Further information can be obtained from:

The Secretary General (Ref. PUB 2/32/3)
South Pacific Commission
P.B. D5.
Noumea Cedex
New Caledonia.

Below is an alternative version produced by the Child Health and Education Project, TMRU University of West Indies, and published in collaboration with Unicef and CFNI.
Artist: D. McDowell



Health Education Snakes and Ladders

This example of Snakes and Ladders in Health Education was designed by P. Kneebone and D. Guthrie for the Disabilities Study Unit in co-operation with the Child-to-Child programme. This version was published in the Journal of Education in Science for Trinidad and Tobago (JESTT, February 1984) and the following was stated

'The centre-page spread which follows is an idea which can be modified endlessly. Change some of the polio clues . . . devise a similar game for gastro . . . for nutrition . . . for safety in the lab . . .

'After you have designed your board, you will have to photocopy and/or Gestefax for the groups.

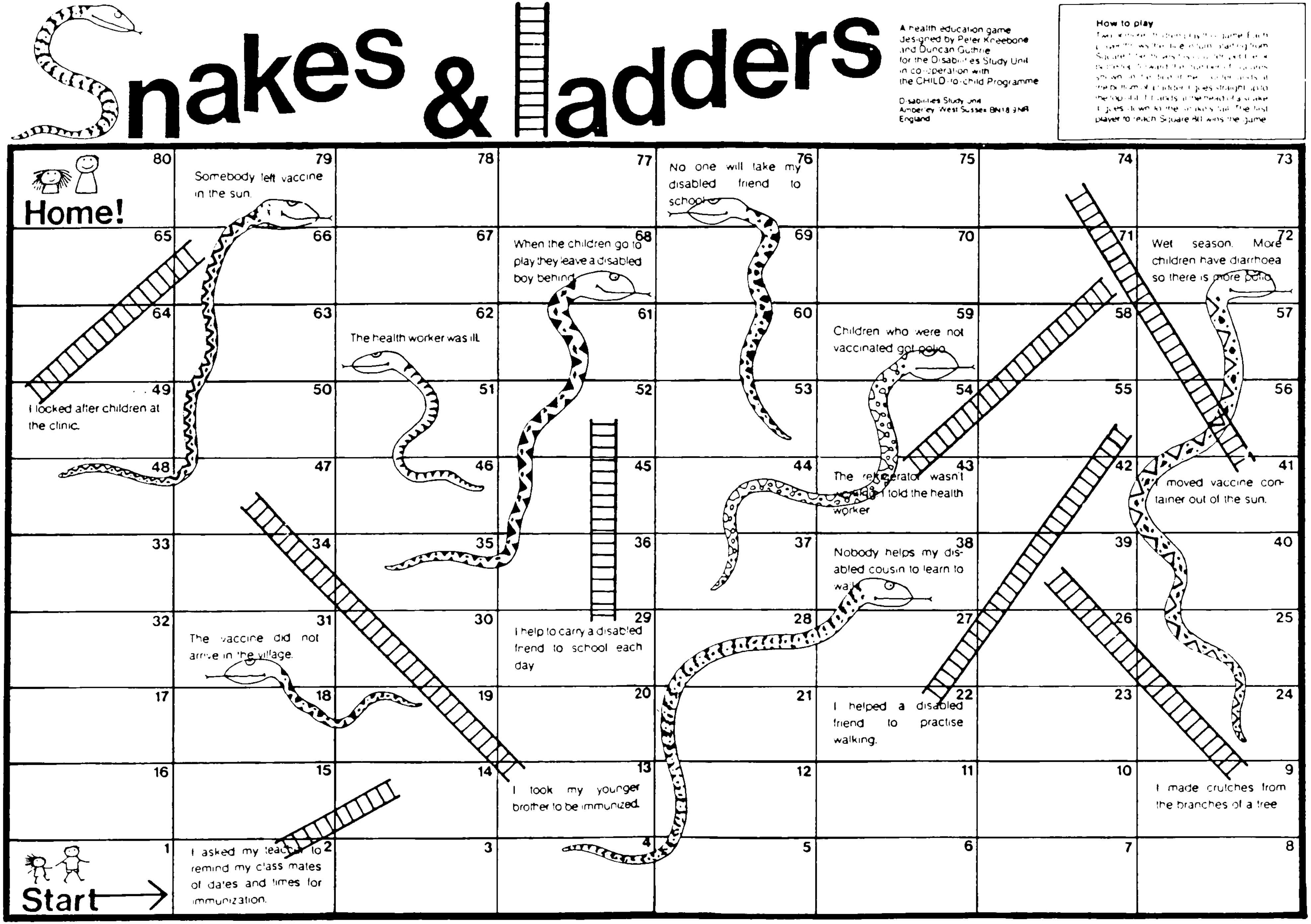
'A word of caution from our experience with classroom games: insist that children read, and can tell you why, they went up and down ladders and snakes. That makes the difference between a game and a learning experience.' (editor's italics)

Further information regarding the Child-to-Child programme can be obtained from

University of London
Institute of Education
Attn: Ms. G. Page
20 Bedford Way
London WC1. U.K.

The address of the Disabilities Study Unit is

Disabilities Study Unit
Amberley,
West Sussex BN18 9NR
U.K.


Snakes & Ladders
A health education game designed by Peter Kneebone and Duncan Guthrie for the Disabilities Study Unit in co-operation with the CHILD-to-child Programme
Disabilities Study Unit
Amberley West Sussex BN18 9NR
England
How to play
player to reach Square 80 wins the game
Home!
80
79 Somebody left vaccine in the sun.
78
77
76 No one will take my disabled friend to school
75
74
73
65
66
67
68 When the children go to play they leave a disabled boy behind
69
70
71
72 Wet season. More children have diarrhoea so there is more polio
64
63
62 The health worker was ill.
61
60
59 Children who were not vaccinated got polio.
58
57
49 I looked after children at the clinic.
50
51
52
53
54
55
56
48
47
46
45
44
43 The refrigerator wasn't working. I told the health worker
42
41 I moved vaccine container out of the sun.
33
34
35
36
37
38 Nobody helps my disabled cousin to learn to walk
39
40
32
31 The vaccine did not arrive in the village.
30
29 I help to carry a disabled friend to school each day
28
27
26
25
17
18
19
20
21
22 I helped a disabled friend to practise walking.
23
24
16
15
14
13 I took my younger brother to be immunized.
12
11
10
9 I made crutches from the branches of a tree
Start
1
2 I asked my teacher to remind my class mates of dates and times for immunization.
3
4
5
6
7
8

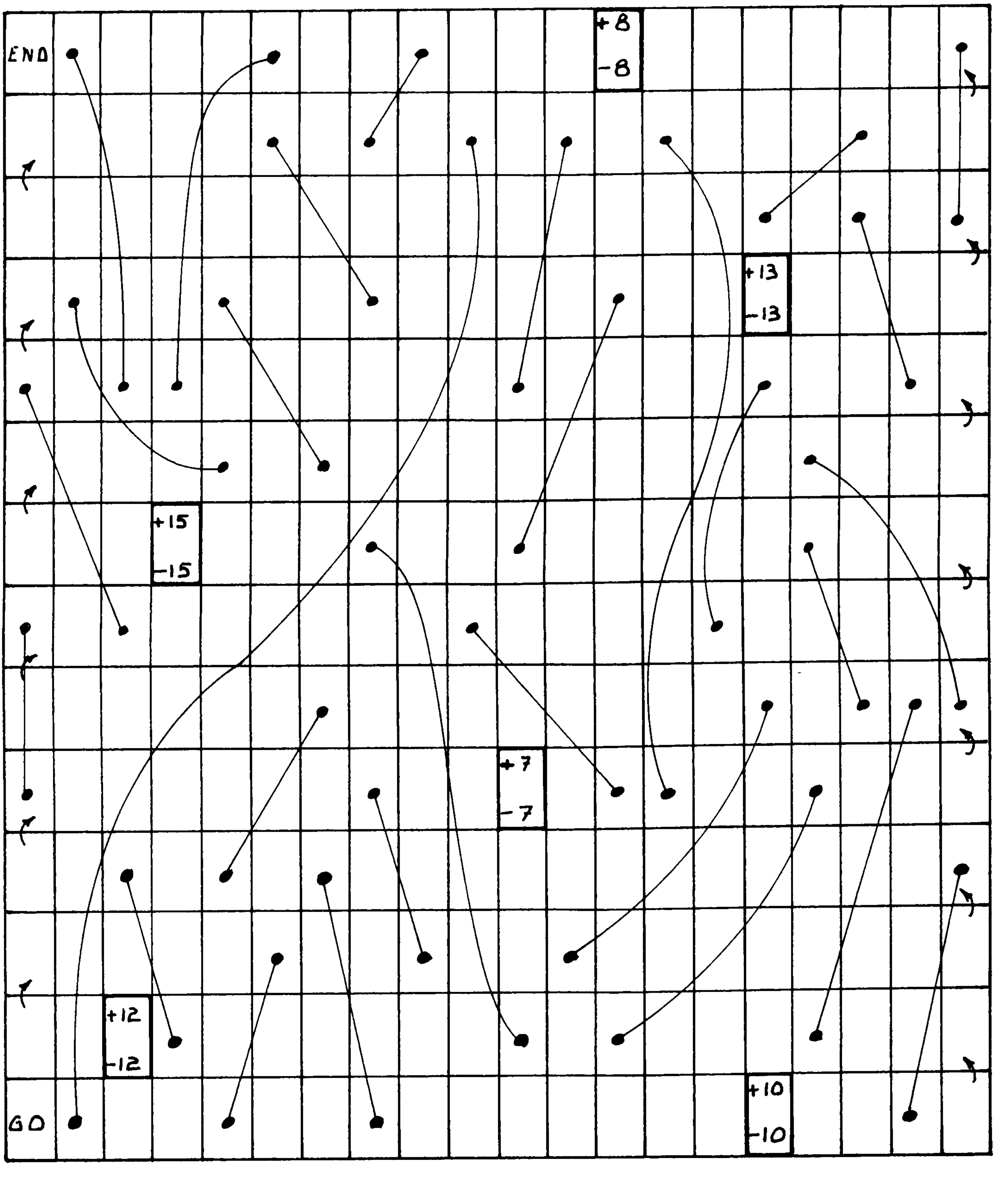
General Purpose Snakes and Ladders

The following snakes and ladders game is an outline which can be used in many ways.

The game was submitted via ICASE and was adapted from that suggested in the School Science Review published by the Association for Science Education, U.K.

1. Snakes and Ladders.
2. Suitable for a large variety of ages of students from 7 - 18.
3. This is a modification of the board game, snakes and ladders.
   a) A suitable board is shown on the following page which can be conveniently made of two sheets of A4 paper fixed together, or by drawing or painting on card when colour can be introduced.
   b) Each player obtains a set of 20 questions and answers, but each set is different.
   c) The game is played by each player putting their counter on the GO square and by shaking and throwing a die, and moving that number of squares.
   d) On the board there are lines linking various squares. These are the snakes or ladders. If you are at the bottom of one of these lines, the line represents a ladder; if at the top the same line represents a snake.
   e) In the course of the game, any player landing on a snake/ladder, is asked a question by his opponent. If the correct answer is given then the ladder is ascended or descending the snake is avoided (the opposite occurs if the answer is incorrect, or no answer is given).
   f) If a player lands on one of the special crisis squares (squares with + and - numbers in them) the other player asks a question they have made up. If answered correctly then the counter is moved forward the number of squares indicated by the figure. If not answered the counter is moved back the number of squares. If the other player cannot think of a question or incorrectly disagrees with the answer, then that player moves his counter back the number of squares instead.
4. This game can be used for revision of virtually any topic, or sub-topic or for general knowledge purposes to find a class 'master mind'.
5. The time required is variable. If the game is not completed within 30 - 60 minutes, the winner is the furthest one up the board. The game is played with two players but with sufficient boards it can be used with the whole class.

Players of differing abilities could be given questions at different levels of difficulty thus making the game challenging to all.



Source: Dussart, G.B. 1984. Snakes and Ladders as an all purpose teaching game. In: *School Science Review*. September 1984. p. 96. Hatfield, Association for Science Education.

Big Ten

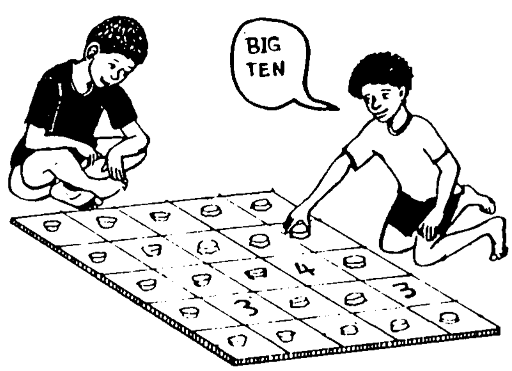
This counting and addition game is suitable for primary level grades 1 and 2.

Materials required
BIG TEN gameboard and 25 bottle tops. The Big Ten gameboard can easily be constructed from Stiff cardboard and is shown in Figure 1. Larger versions can be made for use in the school playground.

Educational Concept/Skill to be developed
i. Reinforcement of addition of numbers up to ten
ii. Logical thinking.

BIG TEN

4	8	2	1	9
3	5	3	3	2
9	4	6	8	4
0	5	1	1	3
7	2	7	5	2



Points for the teacher to consider

This game assists with learning to count up to ten and also assists with memory development since the children soon learn where numbers are located to make up to ten, particularly after the numbers have been uncovered and re-covered a number of times during the game.

Timing: Allow approximately 15 minutes to play the game.
Group size: The number of players should be no more than four per board.

The game can be played as follows

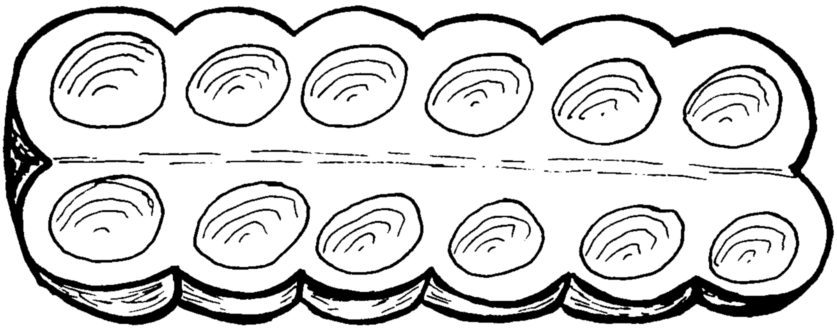
i. Cover all 25 numbers on the game board with bottle tops boards would require larger covers to hide the numbers).
ii. Before each turn the player must state whether they will take two or three bottle tops. The aim is to uncover numbers which add up to ten.
iii. The players take turns in picking up two or three of the bottle tops covering the numbers
iv. If the numbers uncovered add up to ten the player must say 'I have Big Ten' and then keeps the bottle tops.
v. If the numbers uncovered do not add up to ten the player must put the bottle tops back and play passes to the next player.
vi. The winner is the player with the most bottle tops when all possible numbers have been uncovered.

An extension of this game is to make 'Big 15' or 'Big 25' boards.

This game was published in Classroom Maths Games which was the outcome of an Indigenous Mathematics Project established by the Government of Papua New Guinea and assisted by Unesco. The publication states 'The games presented in this book have been adapted from ideas originally published in Make-it Take it Math Games National Council of Teachers of Mathematics, 1978. and Games to Grow on National Institute for Curriculum Enrichment, Rancho Sante Fe, Ca. 1979, both by Carol Winner.'

Mancala

MANCALA is the Arabic name for this particular family of games which have a number of variations. The game can be traced back to the 2nd Century B.C. and is played throughout Africa and elsewhere. The boards may vary from one to four rows and from five to ten holes per row. The following example has been submitted from Nigeria where it is known as AYO in the Yoraba-speaking part of the country. OKWE is the name given in the Ibo-speaking part of the country. (In Senegal the game is known as WARI.)



Description of Game

Suitable for an age range of 6 years and above. Ayo is normally played on a rectangular board in which has been carved 12 'holes' or 'cups", with 6 holes in each row as shown in the sketch above. The game is normally played by two persons and the six holes nearest a player constitute his/her home. Ayo is basically a count-and-capture game and at the start of a game each 'hole' should have four seeds or stones in it. A player commences by scooping up the entire content of one hole in his home and dropping the seeds (or stones) in the following holes, dropping one seed in each hole, and moving in an anti-clockwise direction.

A player only makes a capture if his move ends in a hole in the other player's home and the finishing hole is found to contain two or three seeds. He further captures, as a bonus, the content of the hole immediately preceeding the finishing hole if this is found to contain two or three seeds also. The next preceeding hole can become a further bonus if it also contains only two or three seeds. This 'bonus move' can continue providing the consecutive holes contain two or three seeds and there is no break in the chain, or until at least one hole in the opponent's side is left with stones in it. All captured seeds are removed from the board and kept by the player who made the capture.

The game ends when there are only two, three, or four seeds remaining on the board, and these tend to circulate endlessly without the possibility of any capture. At this point each player adds to his captured seeds those seeds which remain in his home. The player who has captured the largest number of seeds wins the game.

The following constraints apply throughout a game:

i. The players move alternately; a toss of the coin could be used to decide who makes the first move.
ii. A player is denied capture if the capture, including the mandatory bonus captures, would completely empty his opponent's home. The move is allowed but the capture is not.
iii. A move-hole must remain empty at the end of a move. Thus if the move-hole contained several seeds such that the move resulted in a second cycle of 'seed sowing', then the move-hole must be passed over.

It can be seen that many variations can be made on the basic game as described above. Such variations exist both in Nigeria and many other countries.

Educational Concept/Skill that Ayo enhances

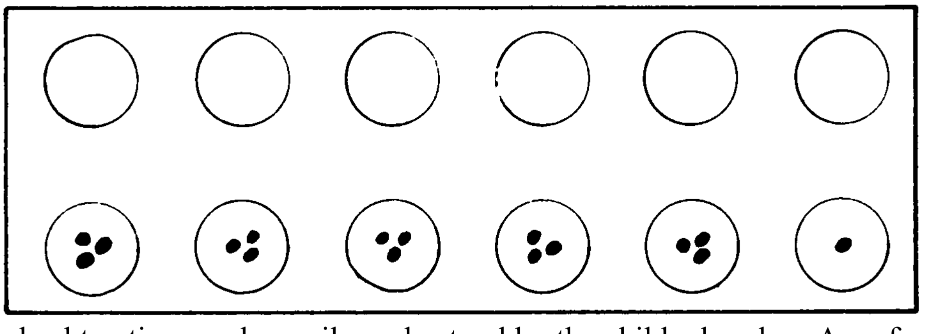
i. Counting: Ayo encourages a player to count quickly and accurately.
ii. Clock - Arithmetic: Because there are twelve holes, and moves are anti-clockwise (or clockwise as the case may be), a child who plays ayo is assisted to read the clock.
iii. Basic Arithmetic Operations: (+, -, x, -): A child will soon recognise that there are forty eight seeds on the board at the start of the Ayo game. The arrangement of the seeds immediately suggests that

$$4 \times 12 = 48$$

The child examines his 'home' which is exactly half of the entire board and discovers that

$$4 \times 6 = 24 \text{ and } 48 - 2 = 24$$

The child can then be guided to see that the usual multiplication table(probably hanging on the wall of the classroom) can be reproduced with ease on the Ayo board. Furthermore, the arrangement in the diagram below illustrates that 3 divides 16 five times with a remainder of one. Similar arithmetic, even with bigger numbers, can be carried out.



Addition and subtraction can be easily understood by the child who plays Ayo; for instance the child can be guided to see the total quantity, the subtracted quantity, and the balance, in terms of the total number of Ayo seeds put on the board, the number of seeds put in his opponent's home, and the number of seeds put in his own home, respectively.
iv. Problem - solving: This is perhaps the most important skill, call it art or science, which the child gradually acquires as he learns the elements of Ayo strategy. He/she learns to compare alternatives before deciding upon a course of action. He/she learns to 'maximise profit' when he is in a good attacking position and, conversely, 'minimise loss' when he finds that several holes in his home are vulnerable and underimminent attack. Moreover he/she learns to plan in the face of uncertainty, as he/she anticipates their opponent's alternatives and maps out their own strategy which will ensure that they win the game.

Points for the teacher to consider

Ayo (or Mancala) could be regarded as the 'national' game of Africa because it is so widespread. One main reason why it is so popular is that the apparatus to play the game is easy to set up. Several African children simply dig-holes in the ground and use pebbles for counters. Elsewhere children may use twelve plastic coffee cups and marbles (or beans)! The teacher should therefore encourage the children to improvise if they cannot obtain the standard Ayo board and Ayo seeds (the hard grey-green spherical seeds of Caesalpina Crista).

The game is normally played by two persons who sit with the board placed lengthwise between them. However, it could be exciting to play 'doubles' or any other convenient group size; in the process the group will be able to discuss tactics and strategy, tactics for short-term advantage and strategy for long-term advantage.

It could also be instructive to time the moves as this could indicate how fast the child is counting and/or how much problem-solving skill they have acquired.

Finally, the teacher should be able to easily monitor the seeds to solve simple problems involving addition, subtraction, multiplication and division.

A Balloon Boat

Suitable for the age range 9 to 12 years.

The Balloon Boat is designed to move on water by the deflating of a balloon. The construction details are not crucial, but the boat should not be too heavy.

Construction details

a) Obtain a piece of expanded polystyrene of approximately 14cm by lOcm by 1.5cm thick. Mark out the four pieces (A, B. C, D) as shown in Figure 1. Place a ruler along the lines drawn and carefully cut along the lines using a sharp blade.

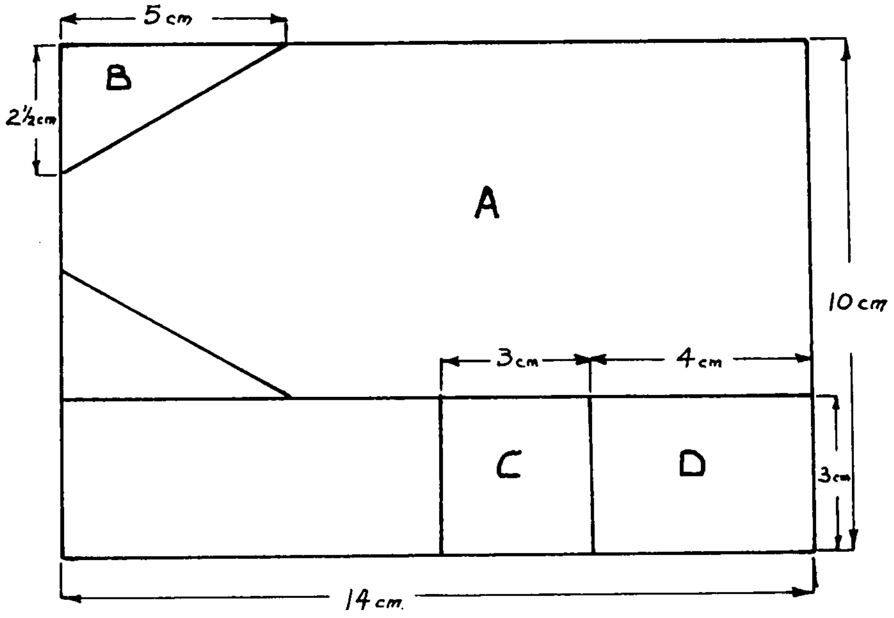


Fig. 1.

b) Fix the pieces B. C and D onto A as shown in Figure 2. To do this use an adhesive which does not dissolve tne polystyrene, or use sellotape or a masking tape.

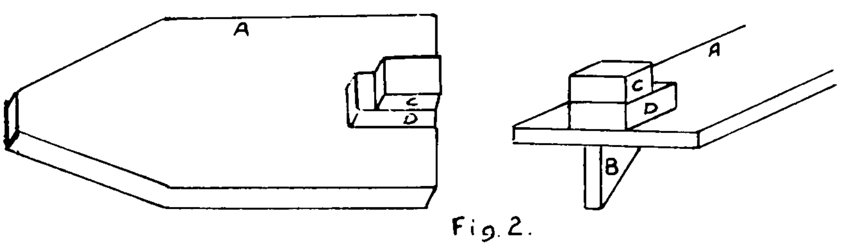
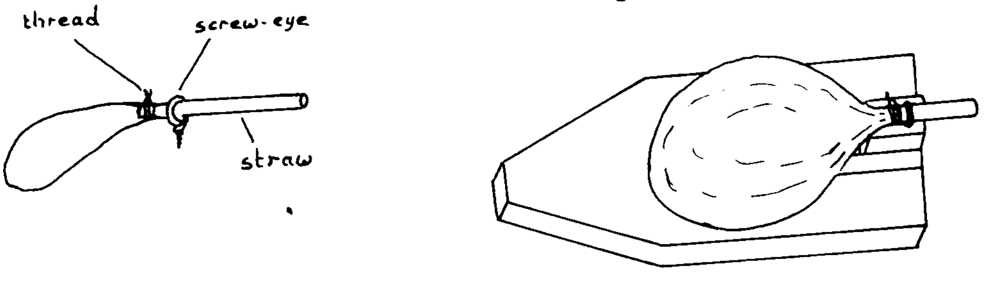


Fig. 2.

c) Fix a straw (plastic straws are best) to a balloon using a piece of thread. Fix the balloon and the straw to piece C using further pieces of sellotape or masking tape(or a screw eye could be used) as shown in Figure 3.

Fig. 3.



Educational Concept/Skill to be developed

This toy leads to the question - Why does the boat move?

i. One concept that can be followed is the energy change from stored energy(potential)to movement energy (kinetic).
ii. Observation and Communication.
iii. Designing and making.
iv. Manipulating materials and equipment effectively.

Points for the teacher to consider

Caution.	The cutting of the polystyrene requires a sharp blade and extreme care and supervision should be taken. The teacher may need to cut the polystyrene depending upon the age and manual dexterity of the pupils.
Timing.	Allow 30 minutes to one hour.
Group size.	The group size for constructing and using the toy should be as small as possible and 2 per group is recommended. This activity could be a project that could be done out of school.

The actual glue to use has not been specified as many different brands exist. A glue that does work well is a white glue often labelled as 'White Glue'.

The children should blow up the balloon and put their finger over the end of the straw. Then place the boat in water, remove their finger and observe what happens.

An alternative balloon boat can be made from an expanded polystyrene dish such as those used in supermarkets for packaging meat and fruit, as shown below.

a) Cut out a 6cm x 2cm strip from the dish as shown in figure 4.

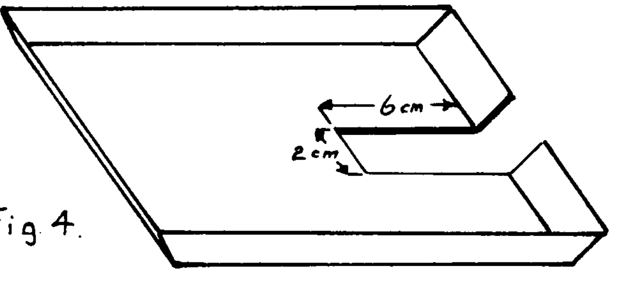


Fig 4.

b) Fix a straw into the balloon using thread. Place the balloon in the dish and securely tape in position as shown in Figure 5.

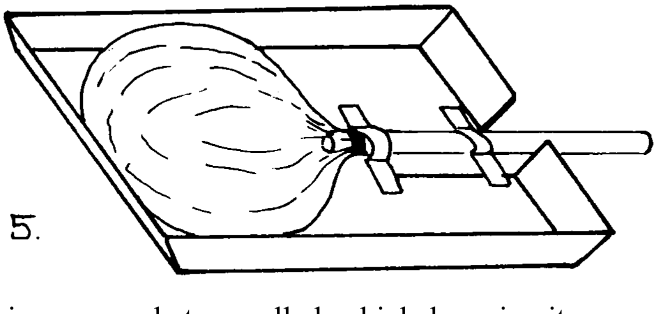


Fig. 5.

A modification is to use this version as a rocket propelled vehicle by using it on a smooth floor rather than floating in the water.

The above toy was submitted via ICASE and was suggested by the Curriculum Development Institute, Singapore.

Koso (A top)

A game for 5 years and over.

The Koso in the form of a piece of conical metal (although a wooden top could also be used) is readily available in African markets.

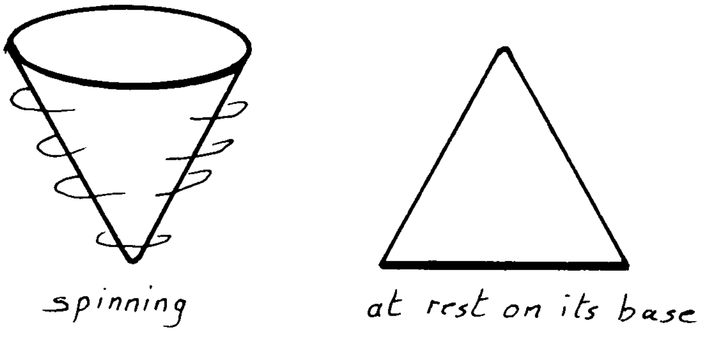
The players take turns in setting the top in motion and terminating the motion of the top in such a way that the top rests on its base. The player is given a credit for each successful play.

Educational Concept/Skill to be developed

i. Finger dexterity
ii. Early concrete foundation for learning about the motion of a top in subsequent years.

Points for the teacher to consider

Timing:	There is no set time limit.
Group size:	Two or more players.
Possible recording:	A point can be awarded for each successful attempt. Alternatively, if there are many players, the method of reinforcement could be by way of eliminating any player who is unable to start or stop the motion successfully.
Repetition:	It can be played both in and out of school.



This game was submitted from Nigeria.

A String Telephone

Suitable for students in the 9 to 12 age range.

A simple method to make a string telephone involves the use of two paper, plastic or expanded polystyrene cups and is as follows.
Make a hole in the bottom of two cups just big enough to pass through a piece of thread or string. Tie matchsticks (or something similar) to the ends of the thread or string, as shown in the sketch below.

Points for the teacher to consider

Timing: Time required is approximately 10 to 15 minutes unless the cups are to be decorated when more time will be required.

Group size: Two students are required to operate the telephone, however, the telephones can be individually constructed especially if it is a competition to see who can make the best (and the most decorative) telephone.

The string telephone can be easily made at home.

An alternative is the Plastic Tube telephone. This is constructed and used in the same way as the string telephone except that a length of plastic tube replaces the string. The tube should not be pushed very far into the cup.

This toy can be used to illustrate that sound travels through solids such as thread or string. This can then lead on to the idea that sound also travels through air and liquids such as water. Discussion could lead to the idea that sound does not travel through a vacuum.

The following is an example of how this toy can be used as a classroom investigation.

Educational Concept/Skill to be developed

i. Sound travels through solid materials such as thread and wood.
ii. Sound travels through water (liquids).
iii. Communicating.
iv. Designing and making.
v. Manipulating materials and equipment effectively.

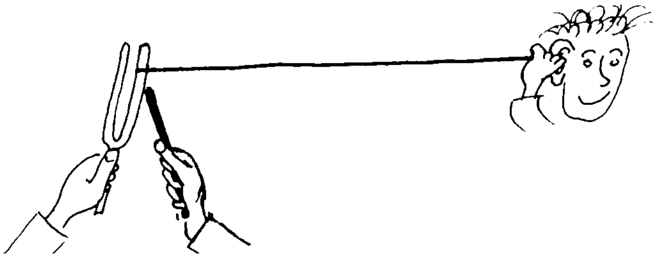
Points for the teacher to consider

Time:	4 x 40 minute periods.
Group size:	2 to 4 children
Recording by the pupils:	each pupil records during each period.
Future activity:	These activities could be followed by an investigation that sound travels in air (gases).

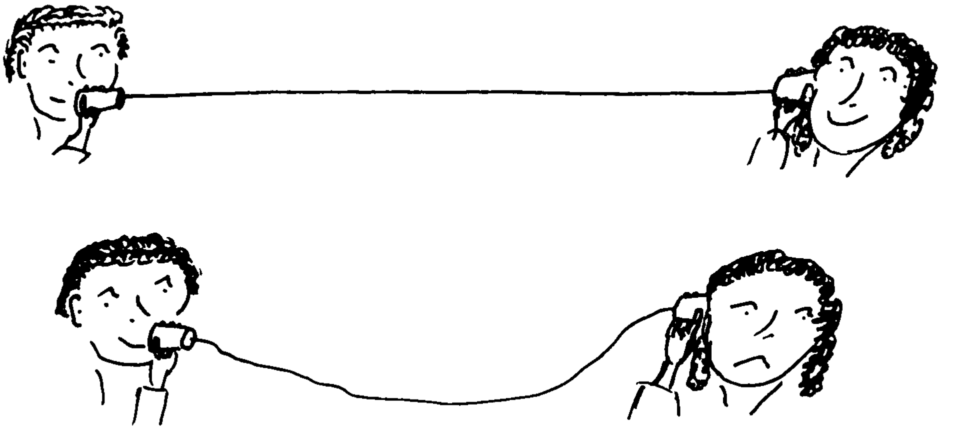
Activities

1. Listen to a sound through a string. Hang a triangle on the string and hold the two ends of the string to your ears. Get your partner to tap on the triangle and then record if you heard anything.

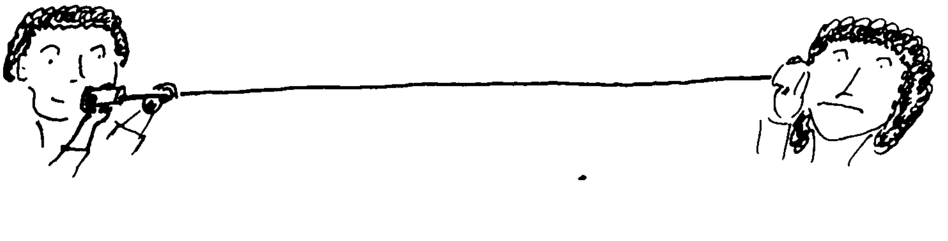
2. Tie a string to a tuning fork. Hold the end of the string to your ear. Get your partner to tap on the tuning fork. Then record if you could hear any sound travelling through the string.

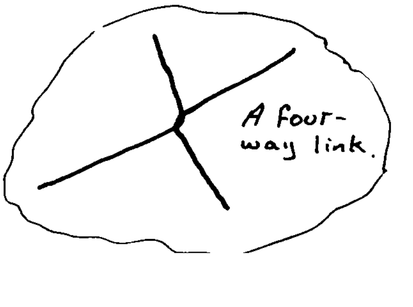


3. Talk (and listen) to your partner, first when the string is pulled tightly between you. Then talk and listen when the string is hanging loose between you. Record which sound is heard most clearly.

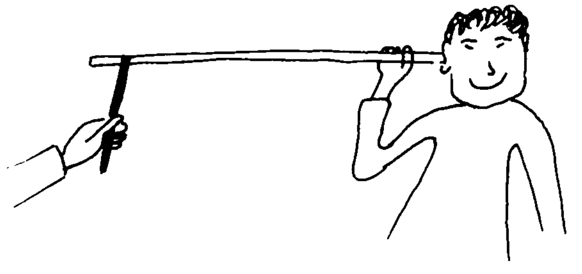


4. Listen through the paper cup telephone while you are holding the string with your fingers. Can you hear the sound?
Try to listen to sounds with other groups. Record whether you could hear anything.

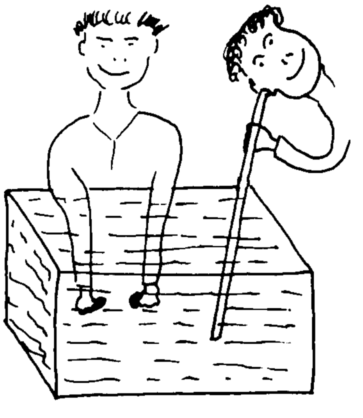




5. Now find out if sound travels through metal or wood. Look for a metal bar or rod and place your ear to one end of the metal and. get your partner to tap the metal. Can you hear any sound through the metal? Now place your ear on one end of your wooden desk and let your partner tap the other end. Record whether you can hear any sound through the metal and the wood.



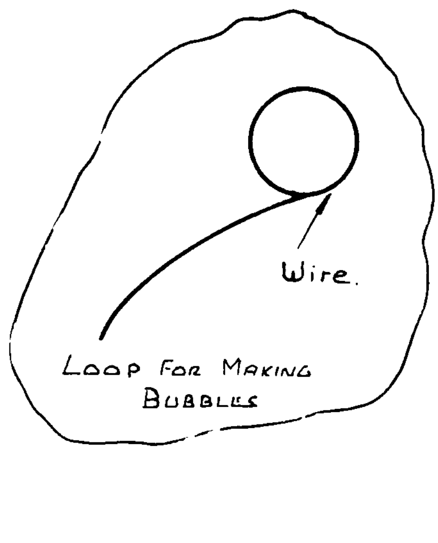
6. Find out if sound can travel through water. Pour water into a large container (a fish tank would do). Dip a rigid tube into the water and place your ear over the open end of the tube whilst your partner hits two pebbles together under the water. Record whether you could hear the pebbles hitting each other.



From your records write down which of your investigations enabled you to hear the sounds and say why you think you were able to hear them. Does sound need a material to pass through? (Here the teacher should hold a class discussion on the findings of each of the groups and drawing the conclusion from the class themselves.)

This example of a toy was submitted via ICASE and suggested by the Curriculum Development unit, Singapore. It has been combined with a second submission via ICASE to provide the example of a classroom investigation.

Bubbles



Almost everybody has had experience of playing with soapy water as a youngster. If your class has not had such an opportunity let them have a try in making bubbles as shown in the sketch above. Some soapy water, a small clay pipe (or a loop as shown in the inset sketch), are all that is needed. Get your pupils to look closely at the bubbles and describe their shape.

An Experiment with Soapy Water

Materials needed

A piece of flexible wire;
A piece of string(cotton thread).

How to make

1. Cut a piece of wire about 40cm long. Any available piece will do, but wire of 0.6 to 1mm diameter will work best.
2. Bend the wire and make a frame as shown in Fig.l.
3. Next, take some cotton thread and make a loop. The loop should be small enough to just fit within the wire frame.
4. Tie a piece of string at two opposite points on the loop; attach each loose end onto the wire frame. Make sure the string is not tight but a little loose.

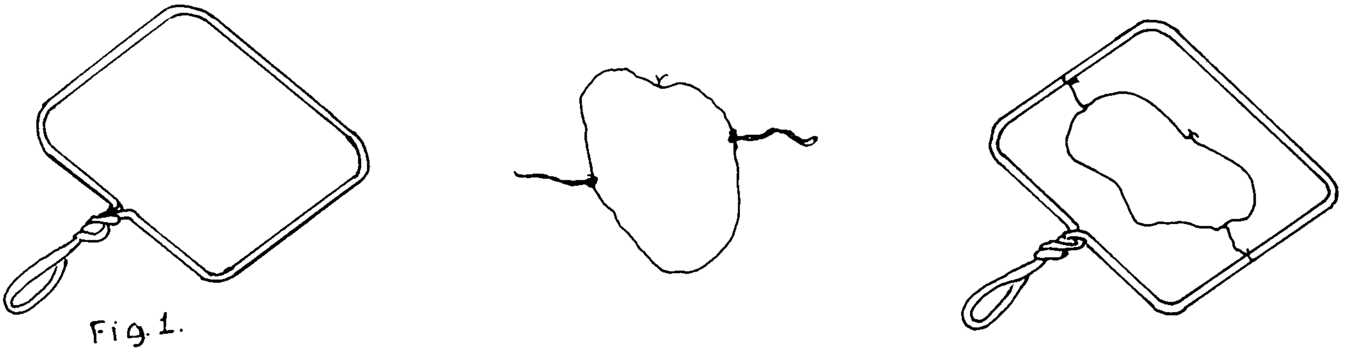


Fig. 1.

Educational Objectives
1. To have fun with an experiment using a self - made toy to be used as a tool for observation of certain phenomena. Similar to other toys made of wire, this is very simple to make. It is important for children to familiarise themselves with science experiments by making their own tools and making observations on some phenomena.
2. Observers will probably discover the surface tension in a film of soap as they watch the cotton loop shape itself into a perfect circle. At the same time, this phenomenon will be practical proof of the fact that among all possible shapes that can be formed out of a given circumference, the circle will take the greatest surface area.
3. Playing with soap bubbles is another game enjoyed by younger children which can also be scientific. This experiment should be regarded as one experiment which has developed from playing with bubbles. Children can experience the transition from mere play into the level of scientific experimentation.

How to use and observe

1. Prepare some soapy water in a wash basin or in a pot, using some soap and water. You need only enough to immerse the wire frame.
2. Immerse the wire frame in the soapy water and then gently lift it out. A thin film of soapy water will form inside the frame.

3. Take a pencil, or use your fingertip, and pop the part of the film that has formed inside the loop of cotton thread. The point of this experiment is to observe what shape the loop will take at this stage.
4. As shown in Figure 2, the part of the film which has popped will form a nice circle. Even if the attached strings are jiggled, the loop will always return to the shape of a circle when released.
5. This illustrates how a film of soap is pulling from all sides, shaping the loop into a circle.

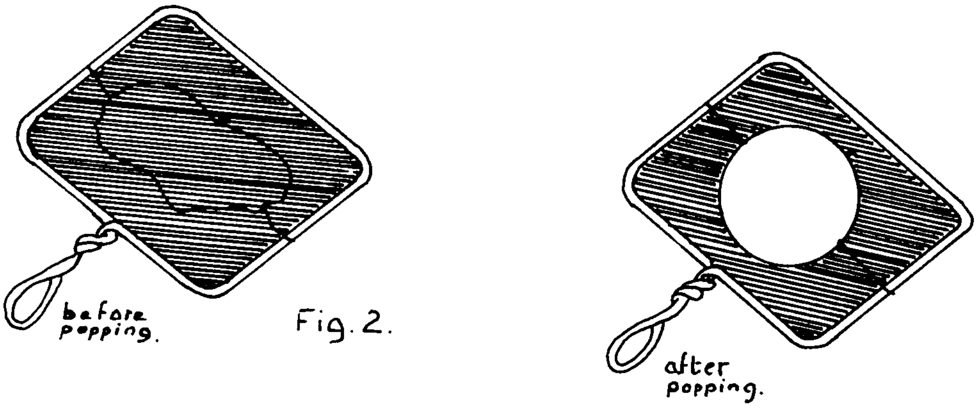


Fig. 2.

Source. Case study of simple low-cost teaching materials, games and toys, prepared by Narikazu Ohsumi, NIER, Tokyo, Japan. and published in *Low-cost Educational Materials Inventory Volume III*, Unesco Regional Office for Education in Asia and the Pacific, Bangkok. 1984.

Crosswords

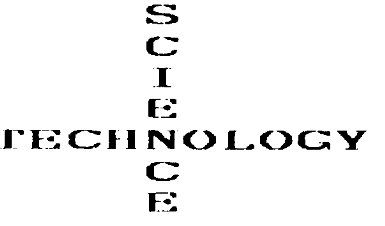
These are suitable for a variety of ages.

Educational Concept/Skill to be developed or introduced

They can serve as a reinforcement and revision tool covering a range of subjects particularly general biology, chemistry and physics.

Information for the teacher

The time allowed should be about 30 minutes per puzzle.
Each puzzle should be individually tackled.



The two examples which follow have been submitted via ICASE who indicate that, in relation to Biology, Chemistry and Physics Crosswords, 'for samples refer to sigma Technical Press, 23 Dippons Mill Close, Tettenhall, Wolverhampton WV6 8HH U.K.'

The following examples would be suitable for the 10 to 14 years age range.

Example 1

Clues Across

1. and 8. Two types of electric circuits. (8 and 6).
5. To come first in a competition is to --. (3).
7. A metal. (3).
11. and 10. To find out the resistance of 2 down you can -- the colour --.(7 and 4).
12. If the amount of 4 down flowing is too small, a bulb will be --. (3).
14. Bare wires can cause this to happen. (5,7).
15. A metal. (4).

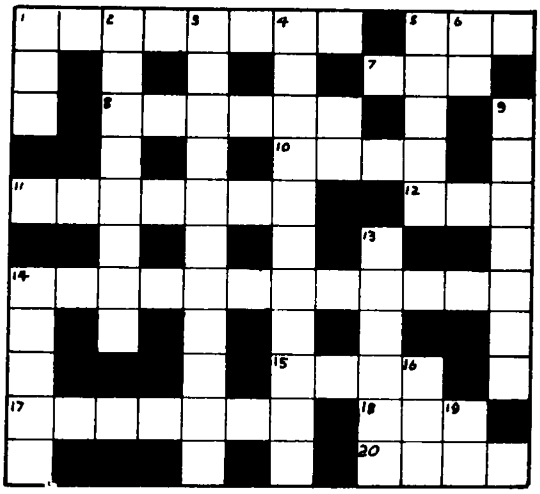
Clues Down

1. 3 down will be of the 3 -- type. (3).
2. When put in an electric circuit will cause a bulb to 12 across. (8).
3. The biggest to fit into a socket. (7,4).
4. Needed for energy in the home. (11).
5. 3 down cannot be used at home unless it is -- . (5).
6. 9 down is connected

17. Both 7 across and 15 across can do this to electricity.(7).
18. A rheostat is -- for maximum resistance before putting in a circuit. (3).
20. An anagram of TOWS. (4).

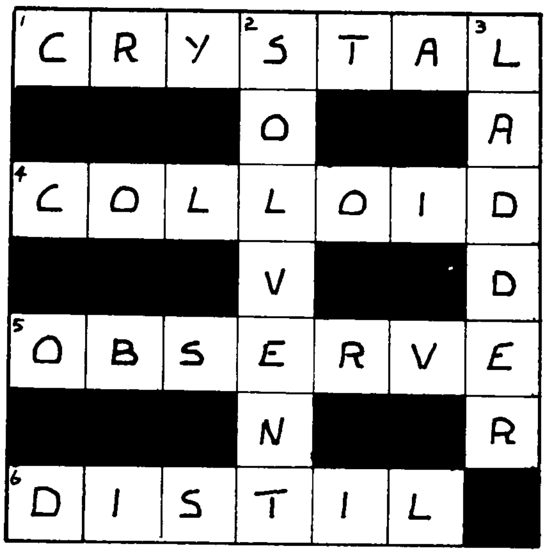
-- the circuit.(2).

9. Used to measure current. (7).
13. A voltmeter is connected -- a circuit. (6).
14. Electricity in the home can be dangerous. It can give you a --. (5).
16. The old is green, the -- is yellow and green. (3).
19. -- 17 across 4 down you can use 7 across. (2).



Example 2

Look at this crossword. The answers have been filled in. But there are no clues. Try to supply clues. Some hints are given.



1. Formed by ____________________
2. ____________________
3. For going up or ____________________
4. ____________________
5. ____________________
6. ____________________

Cross number puzzles

The following selection of puzzles are examples from a range received from Nigeria.

Suitable for an age range of 7 years and over.

The puzzles are similar to crossword puzzles except that the questions and answers are mathematical in nature.

Educational Concept/Skill to be developed or introduced

Each puzzle is keyed to a clearly defined objective. Some drill the children in given computational skills or topics whilst others cover a broader segment of work.

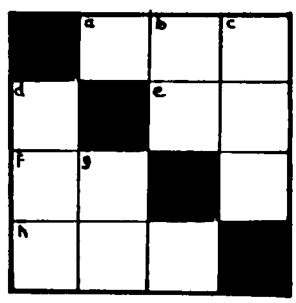
Information for the teacher

Ideally, the children should not be timed.

Example. Puzzle 41.

ACROSS

a. 34 tens plus 3 ones are
e. 19 + 7 =
f. Half of 32 =
h. One hundred and forty four =



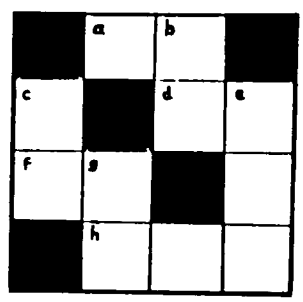
DOWN

b. 55- 13=
c. There are days in one year.
d. Two hundred and eleven =
g. 8X8=

Example. Puzzle 42.

ACROSS

a. 90 - 67 =
d. 2 more than 60 =
f. The sum of 50, 25, and 16 =
h. 130 less 2 =



DOWN

b. The sum of 22 and 14 =
c. 50 + 49 =
e. Two hundred and eighty eight = g. 28 - 17 =

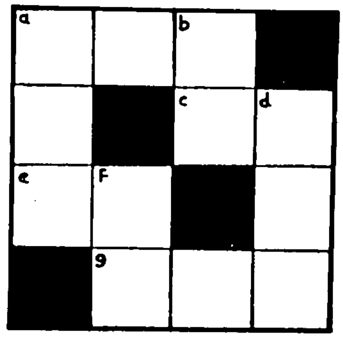
Example. Puzzle 45.

ACROSS

a. One hundred and eleven =
c. 50k + ilk = kobo.
e. 9X7=
g. Twelve tens =

DOWN

a. 1 Naira 56 kobo = kobo.
b. Twenty, take away four =
d. 14 X 10=
f. The sum of 15 and 16 =



Spot the words

Suitable for a range of age levels from 11 to 16 years.

There can be many different games based on this one idea in which the object is to find words hidden in a table, horizontally, vertically, and if desired, diagonally as well as horizontally, vertically, etc in the opposite direction.

Educational Concept/Skill to be developed

The basic skill to be developed is word recognition but this can be extended if the pupils themselves are asked to prepare the games since subject knowledge/recall to a greater depth than word recognition is required. Some examples of this type of game are:

a) Suitable for the 10 to 13 years age range. Find four solids, two liquids, and one gas. One of them (the gas) is given to show you how it is done.

Y	E	T	A	R	A	T	R
E	M	V	L	M	W	A	C
D	E	B	U	T	O	O	D
A	R	T	E	O	W	P	E
I	E	H	A	N	A	T	L
R	G	I	L	M	W	E	R
B	S	D	Y	G	H	S	T
D	A	N	I	L	A	S	E

b) Suitable for the 14 to 16 years age range. Find the ten elements and their chemical symbols with oxidation number + 2 by looking horizontally, vertically and diagonally in the following table.

B	S	N	T	I	N	A	E	I
T	Z	C	I	N	Z	C	D	F
I	C	A	L	C	I	U	M	C
B	A	Z	F	E	K	L	G	A
A	Z	I	N	C	F	E	A	D
R	O	N	E	O	I	A	L	M
I	R	O	N	P	B	D	L	I
U	N	I	O	P	E	F	I	U
M	A	G	N	E	S	I	U	M
E	R	A	F	R	I	U	M	T

c) Suitable for the 12 to 16 years age range. Find the 13 metals which are given in symbol form. The symbols can be read horizontally,vertically and diagonally in both directions.

M	A	N	Y
E	g	i	K
T	I	H	a
A	u	C	N
S	Z	F	e

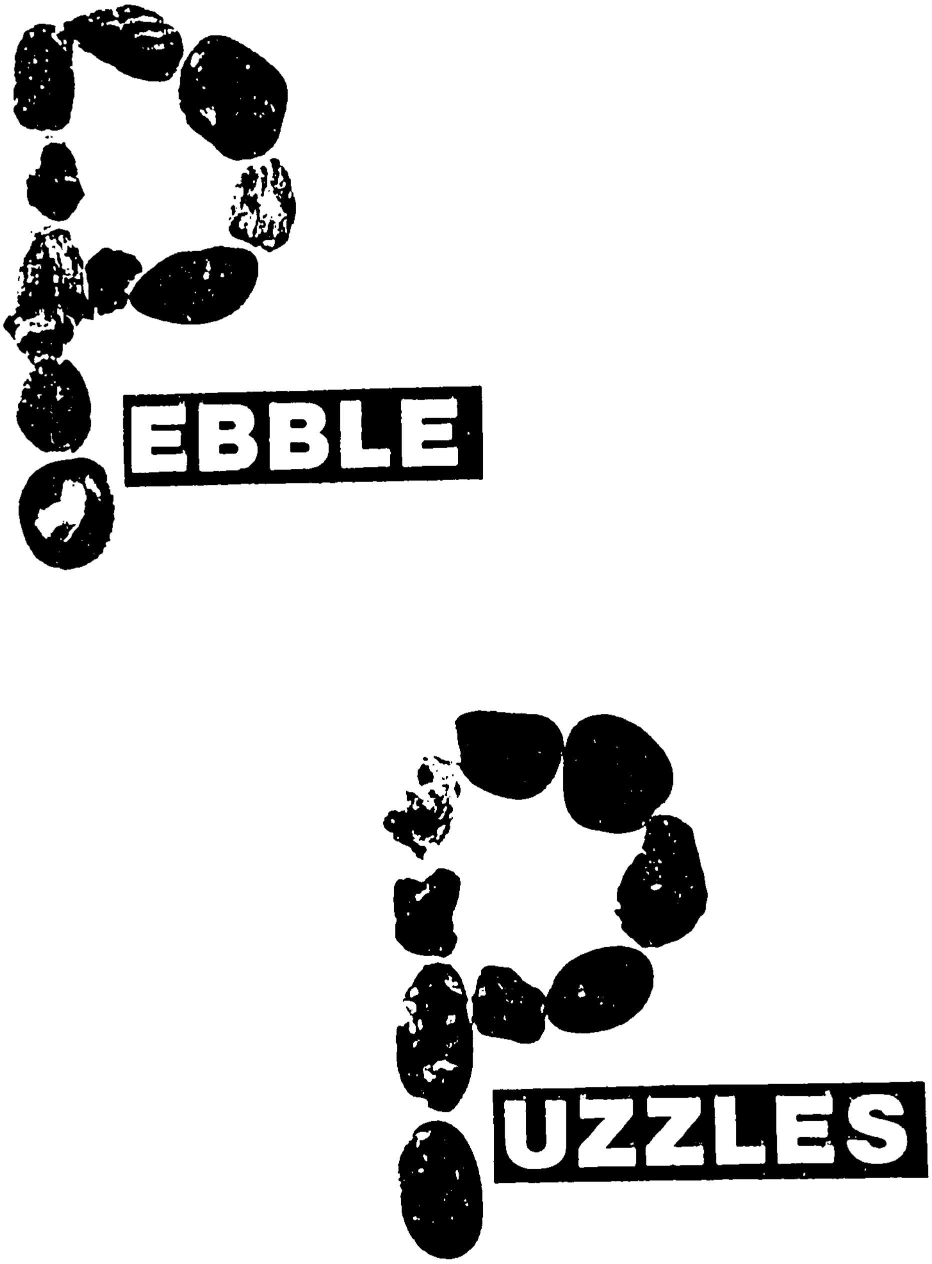
d) Suitable for students in the 16 to 18 years age range. Find the names of the following carbon compounds.

CH_3COOH, CH_3COCH_3, CH_3CHO, $CHCL_3$, $C_6H_5OHNO_2$, C_8H_{18}, $C_2H_5OC_2H_5$, CH_2CH_2

C	O	R	P	E	E	M	T	H	E
M	N	E	E	T	H	E	R	I	T
M	I	A	T	H	A	X	C	T	O
E	T	P	H	E	N	X	C	T	O
T	R	R	A	N	N	I	H	E	X
H	O	O	N	E	O	O	L	Y	Y
P	R	O	P	A	N	O	N	E	
N	H	E	I	R	T	E	R	I	T
A	E	R	C	O	E	P	O	L	H
L	N	A	A	L	R	R	M	I	A
O	O	O	C	T	A	N	E	E	N
A	L	T	I	R	R	A	T	I	E
L	A	E	D	E	A	T	H	E	A
M	E	T	H	A	N	O	A	T	E
O	S	E	T	N	E	I	N	E	R
P	E	D	I	O	I	C	E	E	T

The time required varies, but 15 to 30 minutes is suggested. This type of game is very suitable for learning outside the classroom and students could be asked to devise such games themselves to be played by others.

This game was submitted via ICASE and was extracted from *Finding Out*, Vols. 1-3 by J.B. Holbrook et al., and published by Federal Publications, Hong Kong.



The following examples are taken from a publication produced by the Curriculum Development Unit in the Solomon Islands entitled *Pebble Puzzles - a source book of simple puzzles and problems* prepared by W. Gibbs, 1982.

The following extracts from the Introduction to *Pebble Puzzles* indicate the simplicity of obtaining materials for such games as well as providing valuable common sense for introducing puzzles into our teaching.

'All you need for these puzzles, games and investigations are some stones or shells. Collect some smooth pebbles from the beach, a handful of white ones and a handful of grey or black ones. For the puzzles which need numbered stones use the smooth white ones and write numbers on them with a pencil or felt tip.

'If you want to play the game or puzzle with the whole class then it is a good idea to Inark out the puzzle or game diagram on the floor, or in the sand, or on a loose blackboard laid on the floor. Then you will need large objects instead of small stones. Big smooth river stones or empty tins are easy to handle.

'Children will enjoy playing the games in this book. Perhaps after they have learnt them in school they will play them with their friends after school or with their family at home. But, to enjoy these puzzles children will need to be able to solve them! If the puzzle is too difficult the child will easily get frustrated. In this book I have tried to start with easy puzzles so that every child can begin to feel "I can do this!" Then they will be prepared to work longer on harder puzzles and will gain in determination and perseverence.

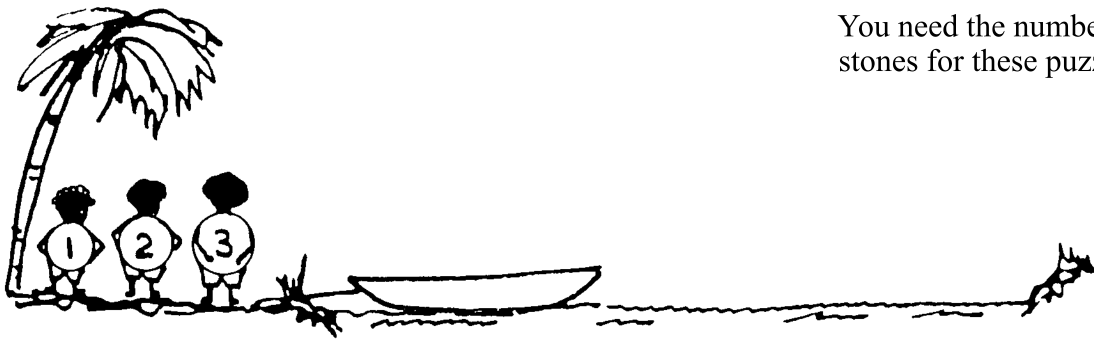
'When children start these puzzles they may use trial and error to find the solution. As they do more puzzles encourage them to think "what will happen if I move here?" Children will need to move the stones at first. Later they will be able to make pictures in their mind of what will happen. This is an important step to learning.

'In many sections in this book after several puzzles there is an "investigation". This is to

challange the more able and older children to think of the rules and patterns that lie behind the puzzles and games. First encourage the children to invent ways of recording their answers. Often they will have to invent their own symbols and signs. Then it is easier to see the pattern or general rule.

'If the children particularly enjoy one kind of puzzle then challenge them to make up similar ones of their own. There is a great chance here to encourage creativity in the child. I think, too, you will find that children enjoy solving puzzles set by their friends more than those set by you.'

CROSSING THE RIVER



You need the numbered stones for these puzzles

PUZZLE 1

Start with stones numbered 1, 2 and 3, on the left bank. Each of the stones is a man who wants to cross the river. Each man's weight is given by his number, 2 weighs two units, 3 weighs three units, 1 only weighs one unit. The boat can only carry a total weight of three units. If more than this is put in the boat will sink.

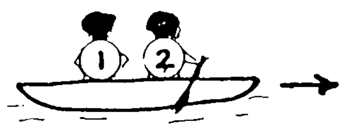
How will the three men cross the river?

Can you do it in 5 journeys?

Remember that someone has to row the boat back across the river to fetch his friend.

Example

First journey



Second journey

What next?

1. and 2. cross

2. stays on the right bank.

1. goes back.

PUZZLE 2

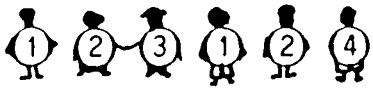
all want to cross the river. This time the boat is bigger;it can carry a total of 4 units.

Can you get everyone across the river in 7 journeys?

PUZZLE 3

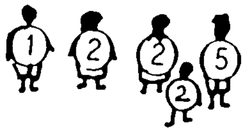
all want to cross. The boat holds 7 units. Can you do it in 9 Journeys?

PUZZLE 4



all want to cross. The boat holds 4 units. Can you do it in 7 journeys?

PUZZLE 5



all want to cross. The boat holds S units. Can you do it in 5 journeys?

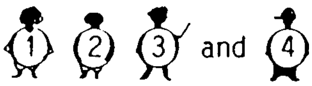
PUZZLE 6

all want to cross. The boat can take any two persons at a time but no two consecutive numbers can travel together (eg. 1. cannot travel with 2.; 3. cannot travel with 2. or 4.) Can you get all across in 5 journeys?

PUZZLE 7

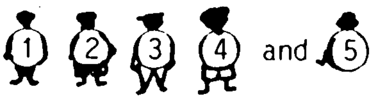
want to cross. The boat holds three persons. Once again no consecutive numbers can travel together. Can you do it in 5 journeys?

PUZZLE 8



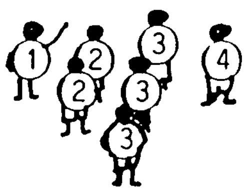
wish to cross. The boat holds two persons only. No consecutive numbers can travel together or be left together on the bank while the boat crosses. Can you do this in 5 journeys?

PUZZLE 9



wish to cross. The boat holds two persons and once again no consecutive numbers can travel together or be left together on the bank. What is the least number of journeys needed for all to cross?

PUZZLE 10



All these people are waiting to cross. The boat holds a weight of 5 units. What is the largest total weight that can cross over in 5 journeys?

INVESTIGATION

(i) What is the greatest total weight that can cross over the river if the boat holds 3 units and you are allowed 5 journeys?

(ii) Can you find a general rule that will tell us the total weight that can cross for all sizes of boats and all numbers of journeys?

Pebble Puzzles contains some twelve different types of puzzles of which 'Crossing the River' is one example.

Food Card Games

Making playing cards for the Food Card Games

i. Make a LIST on the chalkboard of commonly eaten foods.
ii. Write next to each food the food group to which it belongs.
iii. Using playing-card size pieces of cardboard (or other strong paper) make a card for each food item on the list. Draw the food as realistically as possible and then write the name of the food below the drawing.
iv. Preferably, have the children colour the food drawings.

THE FOOD CROUP CAME

One player puts the entire set of cards in a pile face down in front of them. They then turn one card over at a time for theother players to see. Each player must quickly name the correct food group. The first player to identify the correct food group wins the card. When two or more players identify the correct food group at the same time, the card is returned to the pile. The player who has accumulated the most cards at the end of the game is the winner.

NUTRITIOUS MEAL CAME

Six players are dealt four cards each. The remaining cards are spread out, face down,.on the table. Each player looks at his cards to see if they make a nutritious, well-balanced meal. The first player discards, face down, one card that he does notwant and picks up a new card from the table. The next player takes a turn, and so on. Each player tries to make as many nutritious well-balanced meals as possible. Once a player has succeeded in making a balanced meal he places the cards, face up, in front of him (If other players decide that it is not a nutritious meal the player must take back the cards) and pick up four more cards. The player with the highest number of well-balanced meals at the end of the game is the winner.
(A NUTRITIOUS, WELL-BALANCED MEAL contains a GO food, a GROW food and a HEALTHY HELPER food).

MATCH FOODS TO FOOD CROUP CAME

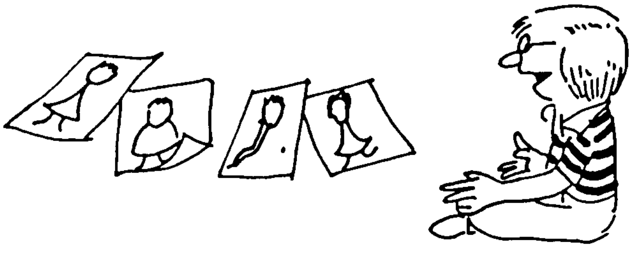
Mix up the set of cards. Deal each player a hand of cards until all the cards have been distributed (Have the pupils playing the game sit at their own desks so that the cards of each player do not get mixed up). Ask each player to put the GO foods in one line, the GROW foods in a second line and the HEALTHY HELPER foods in a third line. Check each players lines to see if they are correct. Players with correct lines can help to check the lines of the other players.

FOOD GROUP MEMORY CAME

This game should be played at the end of several periods of study on the food groups. Cards are spread on the table, face down. Up to six players can play. Each player picks up one card each; another pupil who is not playing acts as the 'JUDGE'. The 'Judge' sees that each answer is the correct answer (if necessary, the judge can use a list of foods and their food groups for reference).
Each player takes a turn. The player whose turn it is reads the name of the food on the card he/she has picked and names the food group that the food on the card belongs to. When a player is wrong, he/she returns the card to the table, face down. A time limit for example, five seconds, should be set to name the food group for the card drawn. The players take turns picking up and naming the appropriate food group until there are no more cards on the table.The player with the most cards at the end of the game is the winner.

This game was submitted by Jamaica.

People Pieces



The following game is suitable for primary grades 1 to 3.

Materials required

One set of People Pieces. These can be made by drawing pictures on pieces of cardboard (or other stiff paper). The pictures should be of people, whole and/or with parts missing ie. leg, arm, etc. They should be coloured pictures and each should be identifiable in terms of sex, colour, and size, eg. adult, child, baby.

Educational Concept/Skill to be developed

The child should be able to
i. Observe and describe the people pieces.
ii. Identify the people pieces being described.
iii. Classify the people pieces according to:
   a. colour   b. sex
   c. size   d. other attributes

Points for the teacher to consider

The number of cards which make up a set is variable and a set of four would appear suitable for a group size of 1 to 2 pupils. A group size of 4 or 5 pupils would require more cards.

The game can be played as follows:

i. Give the children in a group a set of people pieces.
ii. Instruct the children to observe the people pieces being described.
iii. Instruct the children to identify the people pieces being described.
iv. Let the children in the group classify the people pieces according to the attribute they want.
v. Let the children in the group describe the classification made.

This game was one included in a publication Games for Primary Science and Mathematics submitted by the Regional Centre for Education in Science and Mathematics (RECSAM), Glugor, Penang, Malaysia.

Triplets

The following game is suitable for primary grades 5 to 6.

Materials required

One set of cards containing pictures (at least groups of three pictures should be related to each other). These can be made by drawing pictures, or cutting out pictures from papers or magazines and sticking them, on pieces of cardboard(or stiff paper).

Educational Concept/Skill to be developed

The child should be able to -
- i. Develop observational skills,
- ii. Show understanding of relationships and classification by putting together three related pictures.
- iii. Develop logical thinking by following specific directions.

Points for the teacher to consider

The number of cards which make up a set is variable. For a group size of 4 pupils each player should have seven cards with a number of cards to form a pile which can be picked up from.

The game can be played as follows:

- i. Shuffle the cards.
- ii. Deal the cards. Each player should have 7 cards.
- iii. The remaining cards should be placed in the middle, in a pile, with the top card face up.
- iv. Each player looks at their cards. If they have 3 pictures that are somehow related they put them down, face up, in front of them.
- v .Play commences by the first player taking the face up card from the pile if he needs it. If the player takes the card they throw a card from their hand face up next to the pile. Play passes to the next player who can pick up the discarded card or a new one from the top of the pile, and throws one of his own away. Alternatively, the player will pick up a card and put it back in the middle if it does not match the set of three that the player is trying to get.
- vi. The player who has the largest number of triplets at the end of the game is the winner.

This game was one included in a publication *Games for primary Science and Mathematics* submitted by the Regional Centre for Education in Science and Mathematics (RECSAM), Glugor, Penang, Malaysia.

Mathematics Bingo

Suitable for primary grades iv to vi.
Number of players: 9 or more.

Materials required

A Master Bingo Card; Bingo playing cards; pebbles as markers; a set of question cards; an answer sheet. (Although this game is for mathematics the same would apply for any topic or subject.

Education Concept/Skill to be developed

The child should be able to

i. answer specific questions about a subject or topic.
ii. follow specific rules in playing the game.
iii. show honesty and sportsmanship in playing the game.

Points for the teacher to consider

This game can be used as a revision game either at the end of a teaching block or at the start of a new topic.

How to play the game

i. Give each player a bingo card and markers.
ii. Assign a 'caller' to shuffle the question cards.
iii. The 'caller' picks a card from the pile and reads out the number and the question in a clear voice.
iv. The players who know the answer place a marker on the number on their card corresponding to the number of the question. If a player has the number on his card, but does not know the answer to the question, he should not put his marker on the number.
The 'caller' selects another card from the pile and proceeds as described in iv. above.
The game continues until a player has covered all of the numbers on his card. The first player to do so then shouts 'BINGO'. The caller then repeats each question according to the numbers on the players card. The player must answer each question correctly to win.
vii. Should the player who called Bingo not answer each question correctly he is out of the game and play continues until a successful "Bingo" is called.

Questions for Mathematics Bingo

A selection of 27 question cards should be made from the following questions. Alternatively, make up your own questions to suit the level of the class who will be playing the game.

1. What do you call the answer to multiplication?
2. Which is more 2/5 or 5/8?
3. What do you call the answer to addition?
4. What do you call the answer to subtraction?
5. What do you call the answer to division.

6. Nine is (greater than, less than) ten?
7. How many tens are there in 150?
8. What is the next number following the pattern 2, 5, 4, 10, 6, -,?
9. What number is S more than 37?
10. and 3 are prime factors of ?
11. How many minutes are there in one hour?
12. How many days are there in one week?
13. How many metres are there in one kilometre?
14. How many months are there in one year?
15. How many eights are there in 64?
16. How old is Liza if she is twice as old as her 8 year old brother?
17. What is the least common multiple of 7, 21, and 28?
18. Is 6 a prime or composite number?
19. 1/4 and 2/5, are (rational, whole) numbers?
20. is a (proper, improper) fraction?
21. What do you call the distance around a circle?
22. What do you call a four sided figure with two pairs of parallel sides?
23. How many sides has a triangle?
24. How many centimeters are there in one metre?
25. If one metre is 100 centimeters, how many metres are there in 500 centimeters?
26. Is 8 added to 2 equal to 15 less 5?
27. What is 8 times 8?
28. In the number 24,051 what is the value of 4?
29. What is the greatest common factor of 9, 12, and 18?
30. is the same as (2/8,3/9,2/4,1/5)?
31. How many bananas are there in 5 boxes if each box contains 5 bananas?
32. How many sides has a hexagon?
33. What number is 10 less than 45?
34. A pencil cost 50 (cents). How much more do I need if I only have 20(cents)?
35. Which is the smallest fractional unit, 1/2, 1/4, or 1/8?
36. How many nines are there in 72?

Answers to Mathematics Bingo Questions

This list of answers is for use by the 'caller'.

1. Product.
2. 5/8
3. Sum or total.
4. Remainder/Difference.
5. Quotient.
6. Less than.
7. 15.
8. 15.
9. 42.
10. 6.
11. 60 minutes.
12. 7 days.
13. One thousand.
14. 12 months.
15. 8.
16. 16 years old.
17. 84.
18. Composite number.
19. Rational numbers.
20. Improper fraction.
21. Circumference.
22. Parallelogram or rectangle.
23. 3 sides.
24. 100 centimeters.
25. 5 metres.
26. Yes.
27. 64.
28. 4 thousand.
29. 3.
30. 2/4.
31. 25 bananas.
32. 6 sides.
33. 35.
34. 30 (cents).
35. 1/8.
36. 8.

This game was one included in *Games for Primary Science and Mathematics* submitted by the Regional Centre for Education in Science and Mathematics (RECSAM), Glugor, Penang, Malaysia.

MASTER CARD — BINGO

1	10	19
2	11	20
3	12	21
4	13	22
5	14	23
6	15	24
7	16	25
8	17	26
9	18	27

BINGO CARDS

21	14	15
1	10	27
2	5	3

7	24	16
10	1	4
18	13	17

6	2	27
20	23	10
12	24	25

BINGO CARDS

7	4	12
26	20	13
25	24	23

3	14	8
26	4	17
21	7	15

18	16	19
5	11	1
13	22	9

BINGO CARDS.

26	19	5
2	27	3
6	22	8

22	16	18
8	11	6
9	19	17

11	25	23
15	20	14
21	12	9

Food Lotto Spelling Game

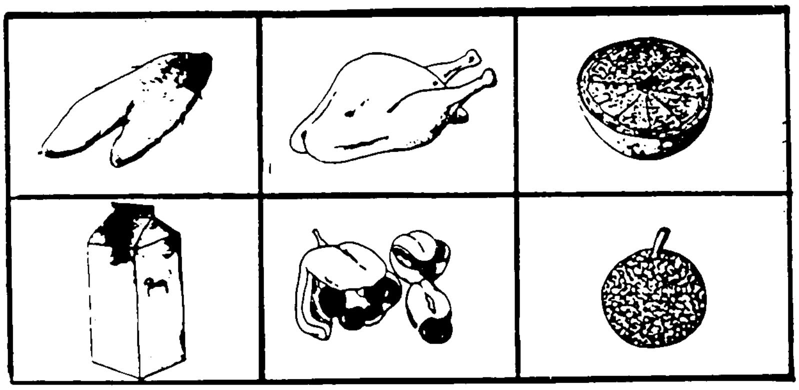
Suitable for an age range of 7 years and over.

This game is a variation of the game of Lotto which is a counters and numbers game. Lotto is also known as Bingo.

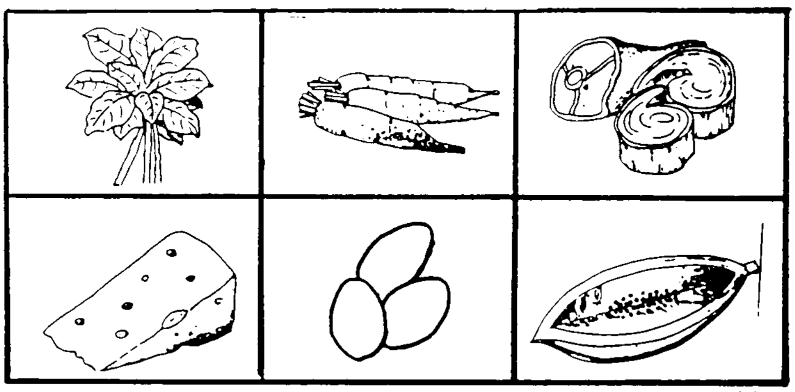
Materials required

Using cardboard or stiff paper make a set of master lotto cards. For a group size of six players prepare five cards. On each card draw six different foods (see Figure l.a - e.). Next prepare the playing (spelling) cards with the name of each food which appears on the master cards (see Figure 2.).

Fig. 1.



1.a.



1.b.

Educational Concept/Skill to be developed

The child should be able to
i. Recognise items of food.
ii. Recognise the name of the food.
iii. Spell the name of the food.

Points for the teacher to consider

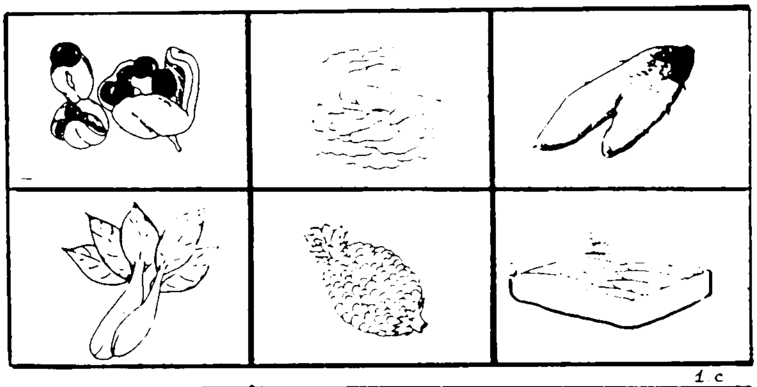
The number of cards which make up a set depends upon the group size. A group size of 6 pupils would require five master cards since one of the group is the 'caller'.

The game can be played as follows:

i. Designate one player to be the 'caller'. The caller then distributes a master lotto card to each player. He also places the playing cards face down in front of himself.

ii. The caller picks up the top playing card and reads out the name on it (the other players should not be able to see the name on the card). Any player who has a picture of the food on his card puts up their hand. The first one to hold up their hand attempts to spell the name of the food, and if he spells it correctly he gets the food card and places it face down over the food picture on his master lotto card.

iii. The first player to cover all six pictures is the winner. Any player who is unable to correctly spell the name of the food, and no other player who put their hand up is able to spell it either, then the caller returns the card to the bottom of the pile.



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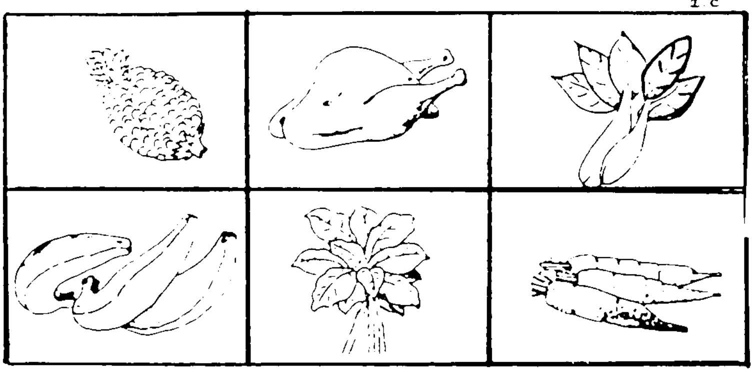

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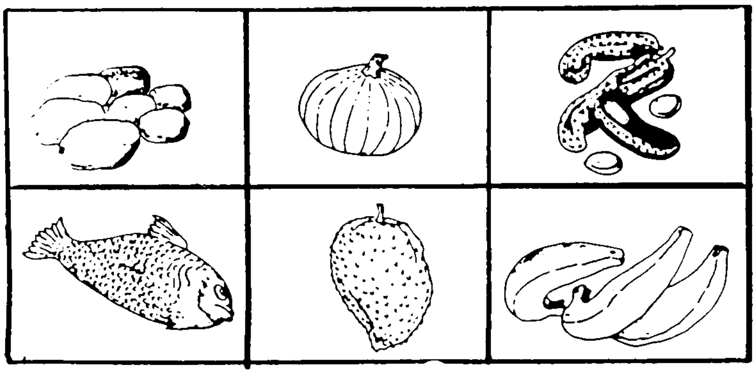
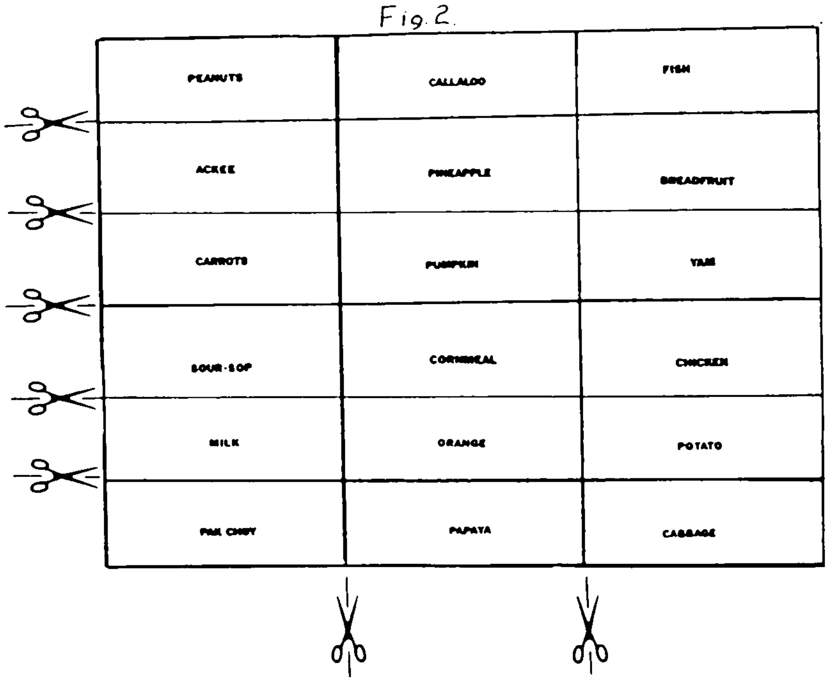


1.e.

Fig 2.



This game was submitted by Jamiaca.

A Simple Periscope

Suitable for the primary and lower secondary levels of education.

This is a simple periscope which can be made out of milk cartons and plastic (or glass) mirrors and can be used for observing objects from behind an opaque object.

Materials required

i. Two empty milk cartons (1 litre size).
ii. A sheet of thin cardboard or drawing paper.
iii. Two mirrors.

Construction details

i. Take the two milk cartons and cut off the upper ends.
ii. Cut a square-shaped window opening close to the other end of each of the cartons. Make a slit close to each of the windows, as shown in Figure 1, so that a mirror can be placed at an angle of 45° to the window (it may be necessary to make a slit on both sides of the carton to hold the mirror steady).
iii. Roll up a piece of thin cardboard or drawing paper an make a cylinder that will fit inside the first carton. Insert one end of it inside the carton, and fix it in place with adhesive tape. Make it so that the second carton will rotate smoothly around the cylinder (see Figure 2.).
iv. Insert the mirrors into the slits in the cartons and assemble the periscope as shown in Figure 3.

Educational Concept/Skill to be developed

i. Reflection of light by mirrors.
ii. Effect of two mirrors which are parallel to each other.
iii. Observation and Communication.
iv. Designing and Constructing.
v. Manipulating materials and equipment effectively.

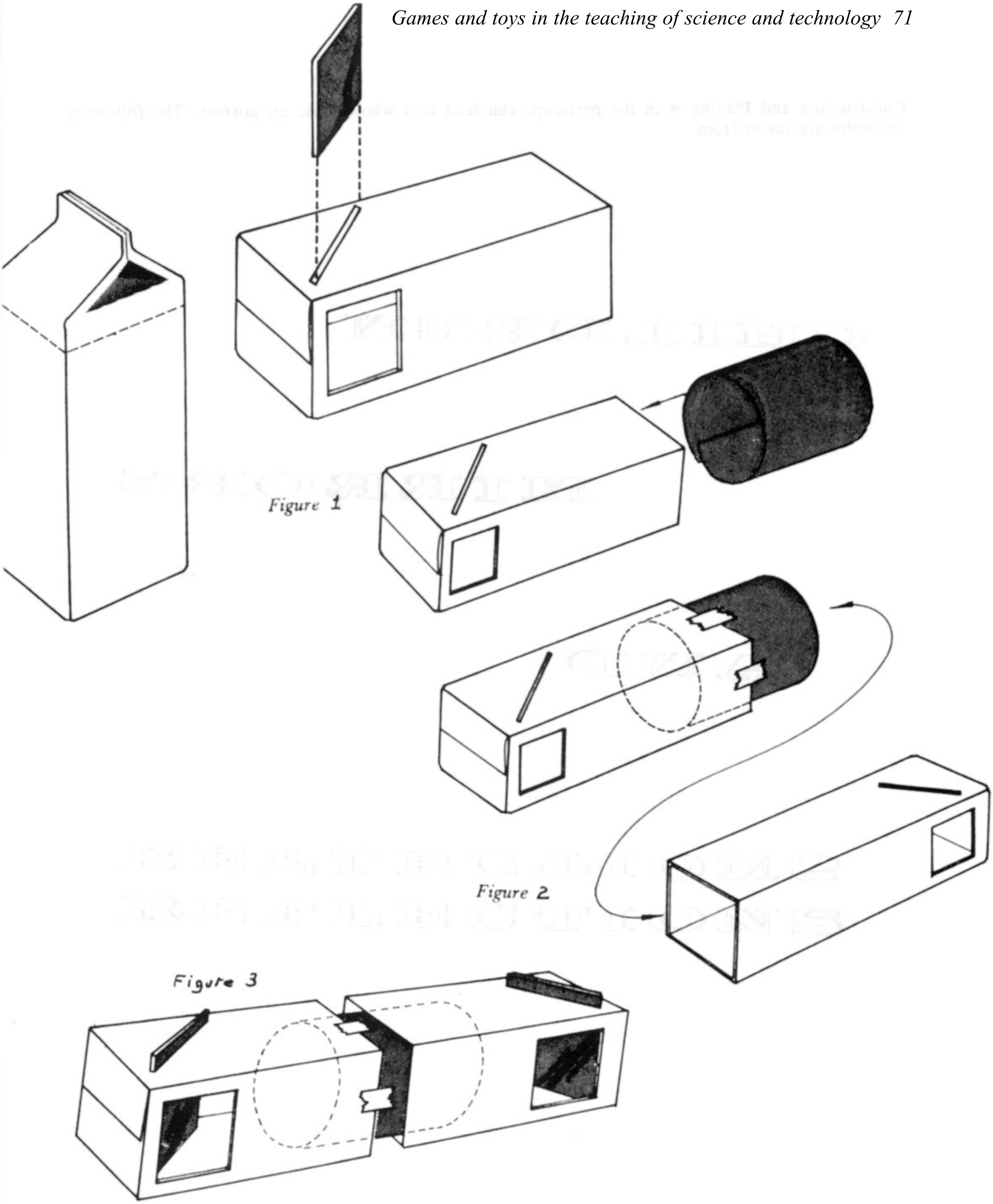
Points for the teacher to consider

The pupils can look through one window and rotate the other one so that the view will keep changing. Objects can be viewed both vertically and horizontally and pupils can be asked to describe what they can see in each case.

Children become absorbed in how things look from under the table or from behind other objects in the room or out of doors.

The pupils will most likely create different kinds of periscopes from the material they are given. For example, they may construct a longer one, or one that can be extended, or one which may have a bend.

Plastic mirrors can be cut into desired shapes and sizes by using a sharp knife, and are safer to handle than glass mirrors.



Source. Case study of simple low-cost teaching materials, games and toys, prepared by Narikazu Ohsumi, NIER, Tokyo, Japan, and published in *Low-cost Educational Materials Inventory Volume III*, Unesco Regional Office for Education in Asia and the Pacific, Bangkok, 1984.

Constructing and Playing with the periscope can lead to a whole topic on mirrors. The following examples are taken from

CHILDREN, MIRRORS AND REFLECTIONS

a publication prepared by Jos Elstgeest as a teacher's guide and presented at the International Seminar on Primary Science Teacher Education, Barbados, August 1987.

Children can do a lot with mirrors

Just give them mirrors

--- and watch

In the mirror... you can look at yourself (or others).
you can look round a corner.
you can look in your mouth

If you hold the mirror above your eyes or your head:

1: everything looks upside down,
2: and in this upside down world
- you can walk and jump,
- shake hands,
- walk a slalom through a line of chairs or stools,
- place something in a matchbox
- and put it on a table.

3: You can try and follow a snaky line on the ground.
Draw the line or use a rope or a garden hose.

Rules:
- never step on it,
- keep it between your legs,
- never look at it,
- unless through te mirror.

4: How long can you stand on one leg in your topsy turvy world?

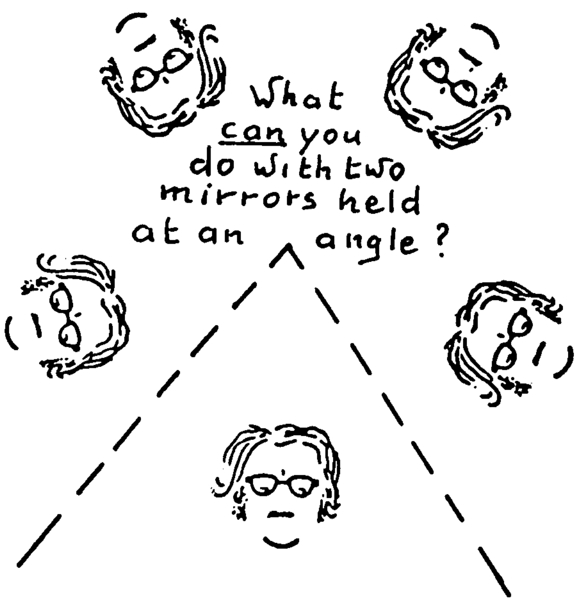
Try and walk through the schoolbuilding (and out of it by the frontdoor) holding a mirror under your chin: look into the mirror held steady, and facing upward.

Can you make a full face out of a half?

or a half face out of a full one?

With two mirrors you can ...

Well,



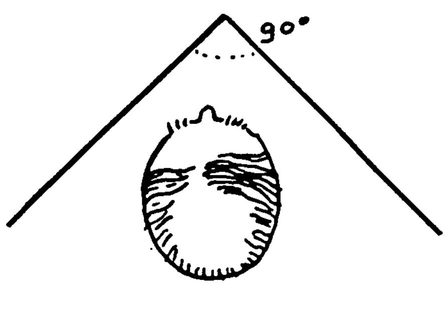
Try this:

- Place something small between two mirrors held upright at an angle
- Count the images measure the angle
- Change the angle and count the images again
- Note what you get

at 180°:	- - - -	images
90°:	- - - -	"
60°:	- - - -	"
45°:	- - - -	"
30°:	- - - -	"

- Make this into a simple graph: x angle, y no. of images
- Can you now figure out a formula which gives you the number of images for any angle?

Look at yourself in this 90° combination...



then wink at yourself.

Can you explain this?

WRITE your name
in mirrorscript

(that is: so that you can
read it in the mirror.)

in blockletters

IN CAPITALS

---

in handwriting

You are allowed to use tricks, but do try it without tricks first.

You may write "mirrorwords" anywhere:
on paper,
on the floor, the ground,
on the blackboard.

Which letters of the alphabeth do not change in the mirror?

Can you write whole words which do not change in the mirror?

... Or a sentence ...

Balancing Figures

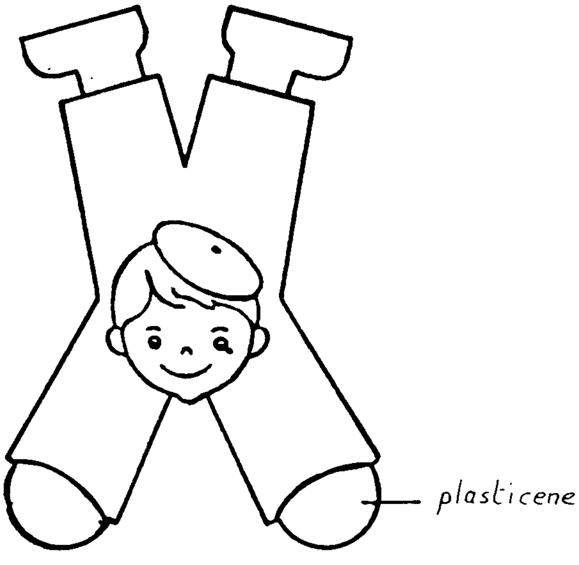
The following two toys are simple to make and can be used as an introduction to balancing and centre of gravity.

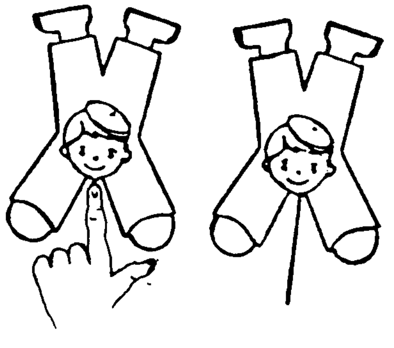
AN ACROBAT

Suitable for the 7 to 10 years age range.

This balancing figure is simply constructed from paper and stiff card, with a little cutting and pasting, as follows.

i. Draw an acrobat by cutting out the figure shown or drawing your own. Make a second acrobat exactly like the first by tracing around the first figure.
ii. Paste the figures onto stiff card. Cut out the figures on the card and stick them together. Brightly colour the figure.
iii. Put a small ball of plasticene around each hand (the balls should be about the same size). iv. Try to balance the figure, as if it were an acrobat, by putting your finger, a pencil, or a matchstick under his chin as shown in the sketch below.





Educational Concept/Skill to be developed

To develop an understanding of balance and stability, leading towards the idea of centre of gravity.

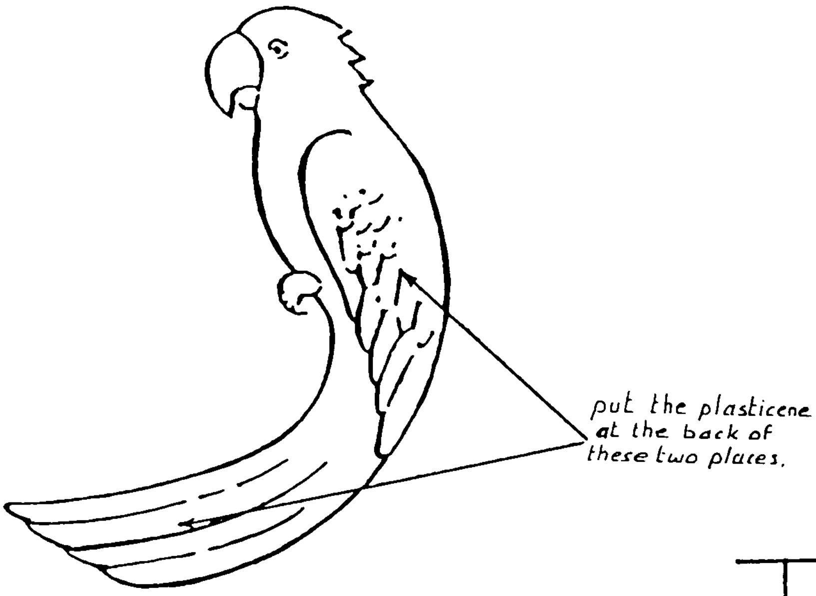
Points for the teacher to consider

Time required. 30 to 60 minutes depending upon the time it takes for the paste to dry.

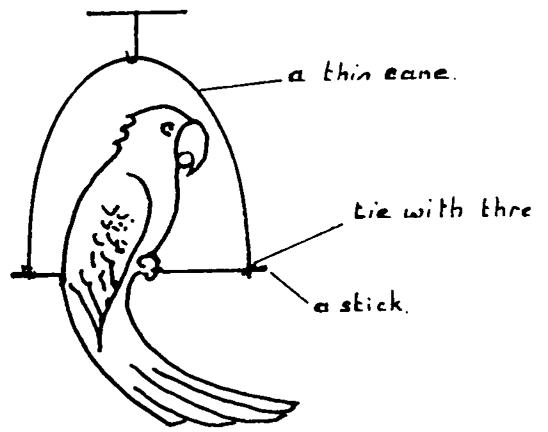
A POLLY ROCKER

Suitable for the 7 to 11 years age range.

To make a pony rocker cut out the drawing of the parrot or draw your own. Then make an identical copy by drawing around the pony and cutting that one out. Paste both parrots onto a piece of card facing each other; colour them both and then cut them out. To the back (uncoloured side) of one pony fix some plasticene in the positions shown in Figure 1. This is to give the pony some extra weight. Stick the two polly's together to form one pony which is coloured on both sides.



Make a stand for your pony as shown in the diagram (A coat hanger may be suitable). Balance the pony on the I stand, and hang the stand where there is a gentle wind blowing, and watch the pony rock backwards and forwards.



Educational Concept/Skill to be developed

i. To develop an understanding of balance and stability leading towards the idea of centre of gravity.

Points for the teacher to consider

Time required. 30 to 60 minutes depending upon the time it takes for the paste to dry.

If used as a class activity with more than one parrot being made, a discussion with the class as to why all of the parrots are not balanced in the same position (amount of plasticene used at each position/relative positions of the plasticene, etc) can lead into investigations on centre of gravity.

These two examples of toys were submitted via ICASE and suggested by the Curriculum Development Unit, Singapore.

Classification of Living Things

Four different card games are included in this game and are designed to achieve the objective of mastering the Classification of Living Things.

The mode of classification used is that of Carl Con Linne as shown below.

Living Things

Plant Kingdom	Animal Kingdom
phyla	phyla
class	class
order	order
family	family
general	general
species	species

Each card for the games has a drawing of the plant/animal, its group, and its characteristics.

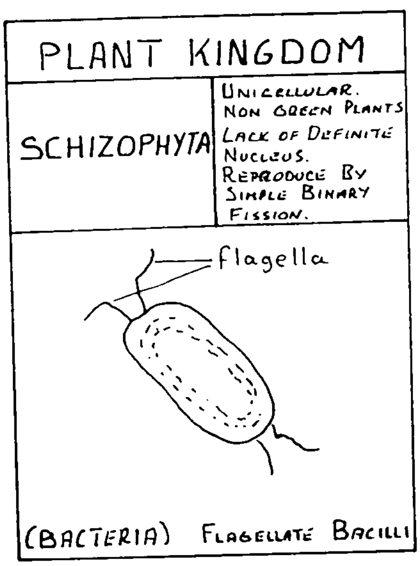
<table>
<tr><td>GROUP</td><td>CHARACTERISTICS</td></tr>
<tr><td colspan="2">PICTURE OF THE
LIVING THING</td></tr>
</table>

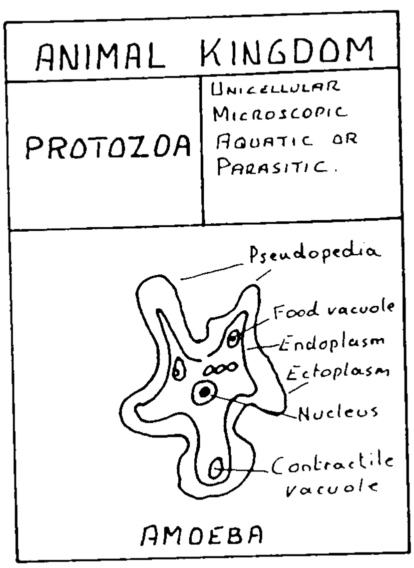
The four different card games are winner takes All, Series, Suspect and Demand and Supply.

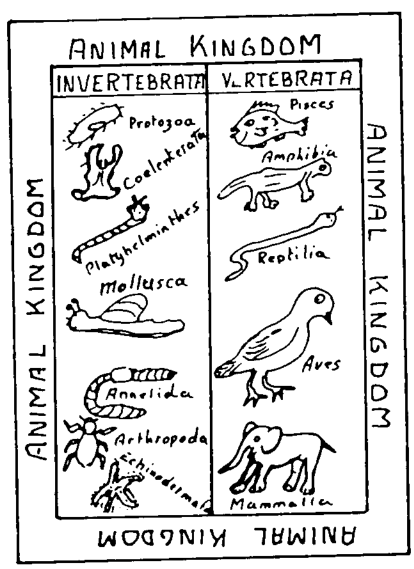
Educational Concept/Skill to be developed

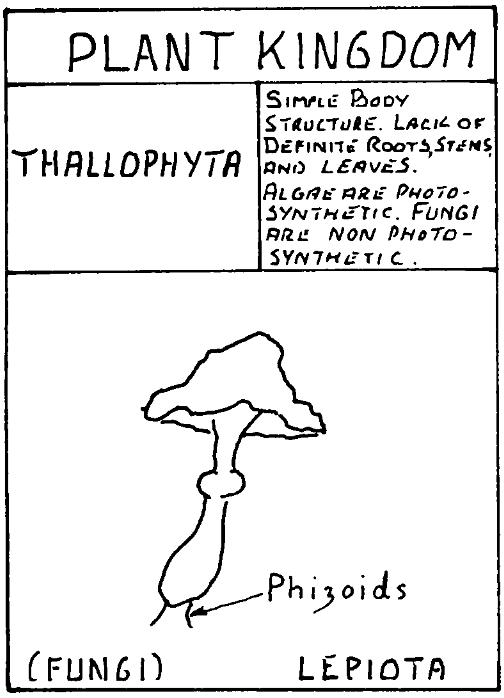
Classification of Living Things.

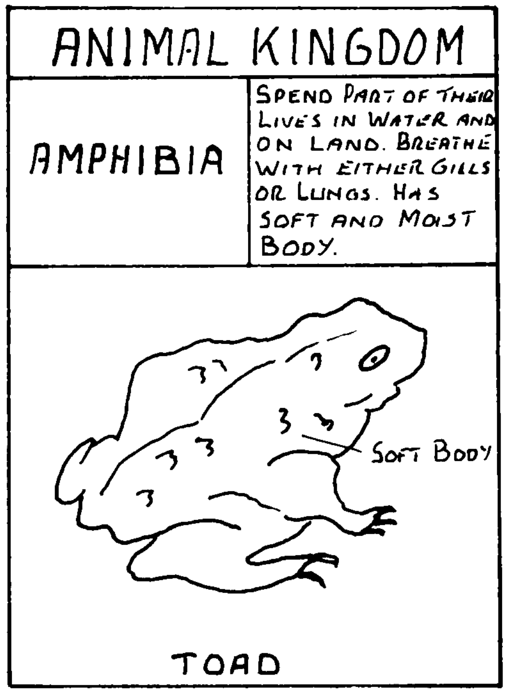
The following are examples of the cards which can be used in the Classification of Living Things games

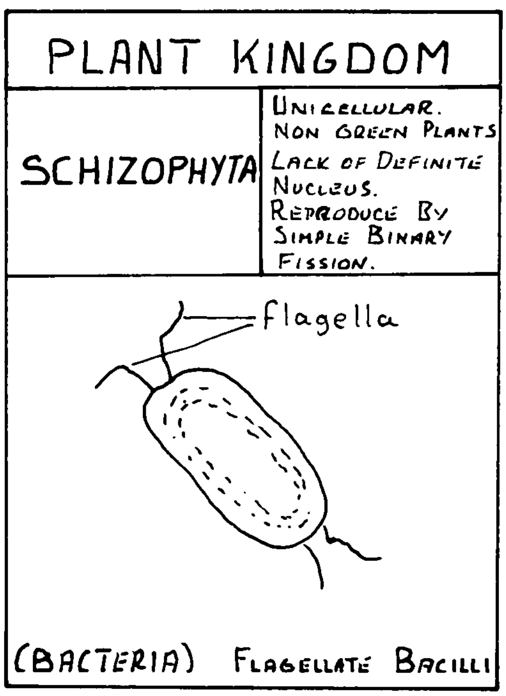


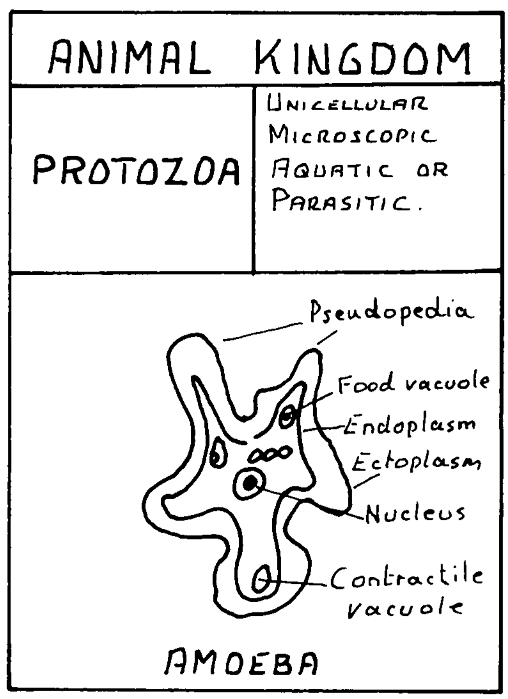


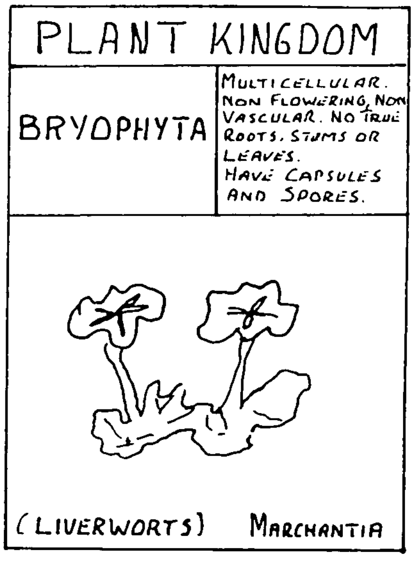


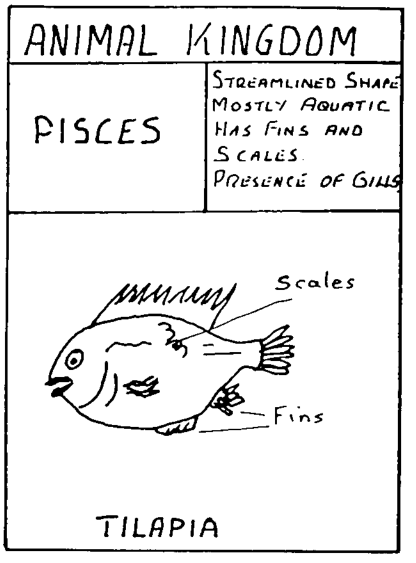

PLANT KINGDOM
THALLOPHYTA
SIMPLE BODY STRUCTURE. LACK OF DEFINITE ROOTS, STEMS AND LEAVES. ALGAE ARE PHOTO-SYNTHETIC. FUNGI ARE NON PHOTO-SYNTHETIC.
Phizoids
(FUNGI)
LEPIOTA

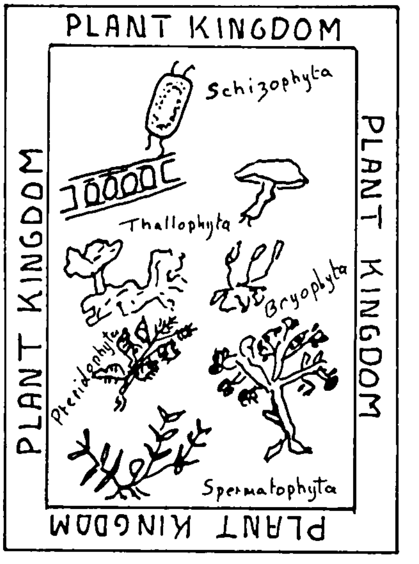

ANIMAL KINGDOM
AMPHIBIA
SPEND PART OF THEIR LIVES IN WATER AND ON LAND. BREATHE WITH EITHER GILLS OR LUNGS. HAS SOFT AND MOIST BODY.
SOFT BODY
TOAD


PLANT KINGDOM
SCHIZOPHYTA
UNICELLULAR. NON GREEN PLANTS LACK OF DEFINITE NUCLEUS. REPRODUCE BY SIMPLE BINARY FISSION.
Flagella
(BACTERIA)
FLAGELLATE BACILLI


ANIMAL KINGDOM
PROTOZOA
UNICELLULAR MICROSCOPIC AQUATIC OR PARASITIC.
Pseudopedia
Food vacuole
Endoplasm
Ectoplasm
Nucleus
Contractile vacuole
AMOEBA







Game 1. WINNER TAKES ALL

Suitable for an age range of 9 years and above.
Number of Players. 2 to 4.

Each player tries to amass as many cards as possible. The game is played as follows

i. One of the players deals out six cards to each player. Each player collects his cards into a pile in front of him and is not allowed to reshuffle the cards once the game has commenced. The remaining cards are placed in a pile, face down, in front of the players.
ii. To start play a card from the centre pile is placed, face up, next to the pile. The first player turns over his top card and compares it with the face up card on the table. If the classification of his card tallies with the face up card displayed he collects both cards.
iii. If the players' card does not tally he forfeits the card and places it on top of the face up card. The next player then turns over his top card and compares it to the top card on the face up pile. If the card tallies the player picks up all of the face up pile of cards, if it does not tally he places his card on the face up pile. The game proceeds in this manner until a player wins all of the cards.

Note. If, at any stage a player loses all of his cards he drops out. The two cards representing the Animal Kingdom and the Plant Kingdom are used as 'jokers' or free cards.

Points for the teacher to consider

Although there is an element of luck in the game it provides the students with an opportunity to learn about the classification of living things.
The players should be allowed to change the rules of the game or introduce new rules to suit their purpose and taste. Such changes should be agreed before the game commences.

Game2. SERIES

Suitable for an age range of 9 years and above.

Number of players Two to four.

Each player aims to form a series of three cards that can be classified together(based on Linne's seven subgroups). The first player to collect three such sets calls for the end of the game and is deemed the winner.

The game is played as follows -

i. The cards are dealt out by one of the players and each player receives nine cards. The remaining cards are placed, face down, in a pile between the players. This pile is referred to as an 'open market'. The top card from the open market is placed face up next to the pile.
ii. Each of the players examine the cards they have received to see if they are able to make one or more series. Each player also considers the cards in terms of groups that can be made.
iii. The first player can pick the face up card from the table if it will be of use in forming a series. Alternatively, he player can select the top card from the open market. The player either keeps this card or places it on the face up pile. If the player keeps the card then they must throw away another card from their hand since they can only hold the number of cards they started with.

Note. The Kingdom cards can be used to complete a series of groups within their Kingdom; i.e. if the player has two plant cards, the plant kingdom card can be used to complete the series.

Game 3. SUSPECT

Suitable for an age range of 8 years and above.

Number of players. Two to four.

This is a game of bluff. The first player to get rid of all of his cards is the winner.

The game is played as follows -

i. All of the cards are dealt to the players. The first player lays a card, face down, and announces the group of the living things drawn on it. He also lays down other cards which belong to the same group. since the player puts the cards face down he is at liberty to include a card that does not belong to the group, on the pretext that it does. However, he runs the risk of being detected and penalised.
ii. When the first player has laid down all of the supposedly related cards he gives the go-ahead for the next player to play. This player can start with a new group or continue with the former group.
iii. Whilst a player is laying his supposedly related cards any other player might suspect foul play, and can shout 'Suspect'. The player then turns his card over for inspection. If the card played does belongs to the announced class the player who raised the alarm is forced to collect all of the cards laid. This reduces his chances of winning. However, if his suspicion is justified i.e. the card laid does not belong to the group, the player who cheated collects all of the cards laid.

iv. When a player succeeds in laying all of his cards he calls for the end of the game and is the winner. The other players can be ranked in order depending upon the number of cards each player is left with. The fewer the cards held the higher the ranking.

Points for the teacher to consider

This game is also a game of strategy. A player may deliberately appear to cheat but in fact lay down a card of the correct group thereby causing another player to shout "Suspect". In such a case the challenger then has to pick up all of the cards and possibly lose the game.

Game 4. DEMAND AND SUPPLY

Suitable for an age range of 10 years and above.

Number of players. Two.

The game is played as follows

i. The pile of cards is placed, face down, on the table. The first player picks up a card and asks his opponent a question. The questions can be of two types
   a. List the characteristics on the card and ask the opponent to name the group having such characteristics; or
   b. Give the group name and ask for one or more characteristics of the group.
ii. If the opponent answers the question correctly he collects the card. If the answer is incorrect the person who asks the question keeps the card for himself.
iii. When a player answers a question correctly he has the option of taking over the questioning or continuing to answer questions. The question and answers continues until the cards are exhausted.
iv. The players then count their cards. The player with the highest number of cards is deemed the winner.

Points for the teacher to consider

Scoring- each card can be given a weighting of one mark. At the end of each game the score of each player can be recorded. The players can play the game a number of times, after which the grand total for each player can be calculated.

This series of four games was submitted by Nigeria.

A Hovercraft

Suitable for the age range 9 to 12 years.

This toy can easily be constructed from an expanded polystyrene container as used by fast-food stalls. The toy can illustrate that air under pressure can exert a force, in this case sufficient to lift the toy off the table so that it can easily move.

Educational Concept/Skill to be developed

i. Air has pressure and can exert a force.
ii. Observation and Communication.
iii. Designing and Construction.
iv. Manipulating materials and equipment effectively.

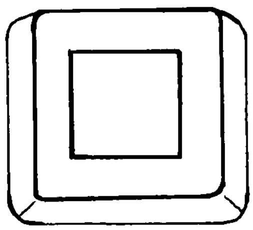


Fig 1.

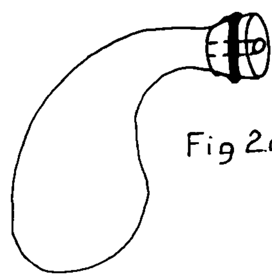
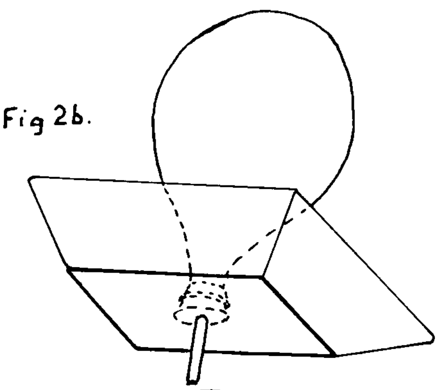


Fig 2a.

Construction details

a) Separate the lid from the rest of the container. Cut a hole of 6cm x 6cm in the centre of the lid as shown in Figure 1. Trim the edge of the lid so that it will fit inside the container.
b) Make a hole in a cork just large enough for a straw to pass through. Insert the cork into the mouth of a balloon and fix in place using an adhesive tape. (see Figure 2a).
c) Using a pencil make a hole in the centre of the base of the container just large enough for a straw to pass through. Pass a straw through the hole and allow it to pass through the cork. With the straw still in position firmly fix the cork over the hole in the container as shown in Figure 2b, using adhesive tape. Finally, insert the lid into the container (Figure 3).
d) Blow up the balloon through the straw. Remove the straw and quickly place your finger over the hole. Put the toy on a smooth surface, remove your finger, and the toy will move across the smooth surface.

Fig 2b.


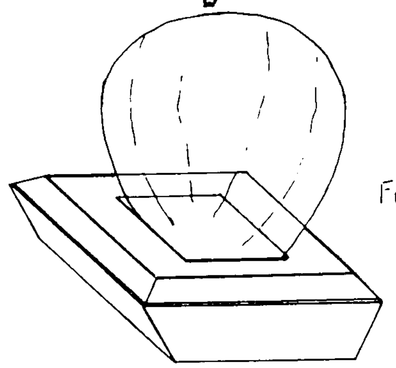


Fig 3.

Points for the teacher to consider

This toy can illustrate that air under pressure can exert a force, in this case sufficient to lift the toy off of the table so that it can easily move.

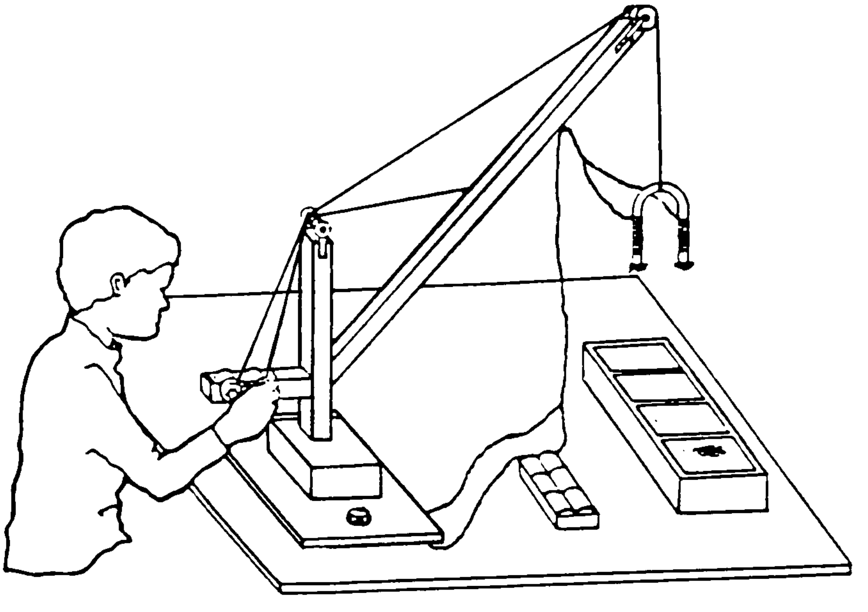
Caution.	The cutting of the polystyrene lid requires a sharp blade and extreme care and supervision should be taken. The teacher may need to cut the polystyrene depending upon the age and manual dexterity of the pupils.
Timing.	Allow 30 minutes to one hour.
Group size.	Group size is best kept small (two per group is appropriate). This activity could be developed as an out of school project leading up to an in school activity.

The above toy was submitted via ICASE and was suggested by the Curriculum Development Institute, Singapore.

An Electromagnetic Crane

Suitable for the 8 years and upwards age range.

This crane is an example of a 'construction toy' which can be made by pupils working in groups of two.



Educational Concept/Skill to be developed

i. an understanding of electromagnetism and its application.
ii. an understanding of mechanics and the application of levers, pivots, structures, etc.
iii. designing and constructing.
iv. manipulating materials and equipment effectively.
v. observation and communication.

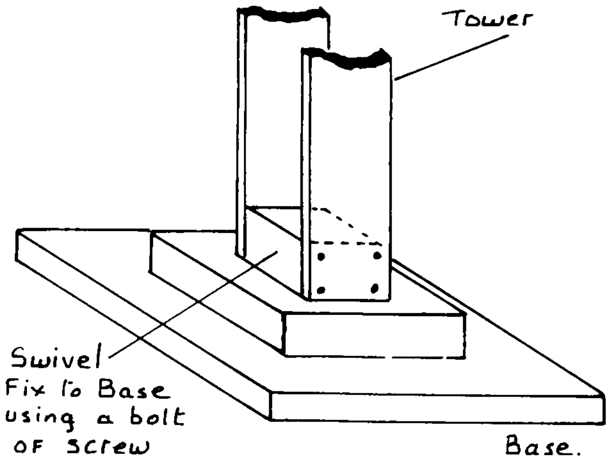
Construction details

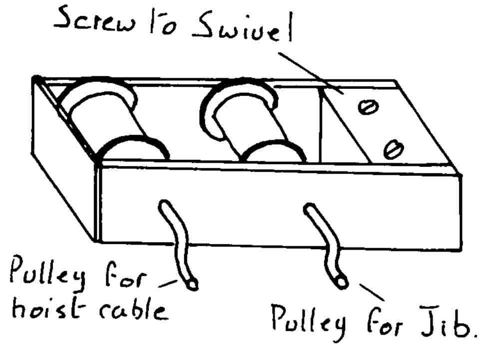
The exact dimensions of each of the parts will depend upon the material available to the teacher and the specific design of the pupils. The components which make up the crane are shown in the following sketches.

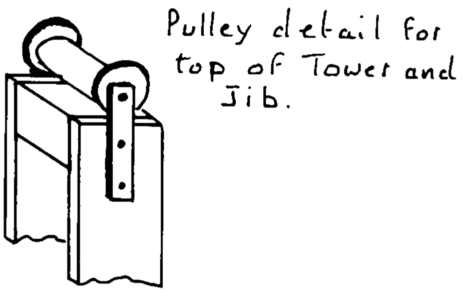
Points for the teacher to consider

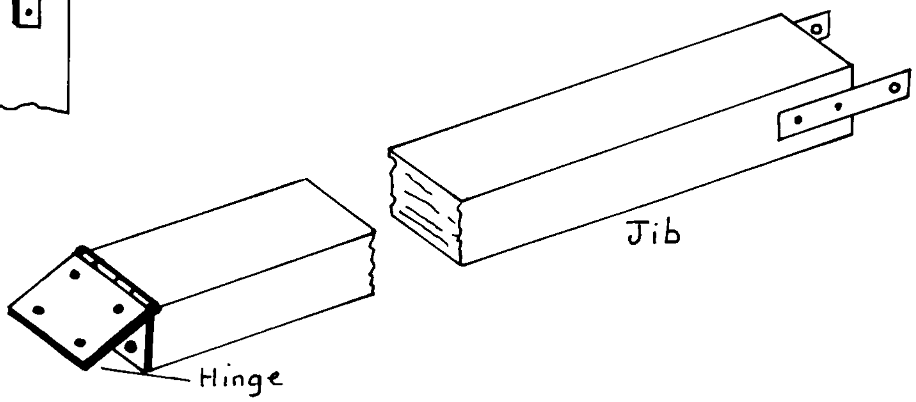
The angle of the jib can be varied by turning the pulley and varying the length of cord wound on the pulley. Similarly, the height of the magnet can be varied by turning the second pulley.
The crane can be rotated by turning the tower on the base.
Allow some 15 minutes for the group to set up and demonstrate the use of their crane. Then suggest a series of variations on using the crane such as, varying the load for fixed positions of the jib. This would lead to an observation that light loads can be lifted with the jib

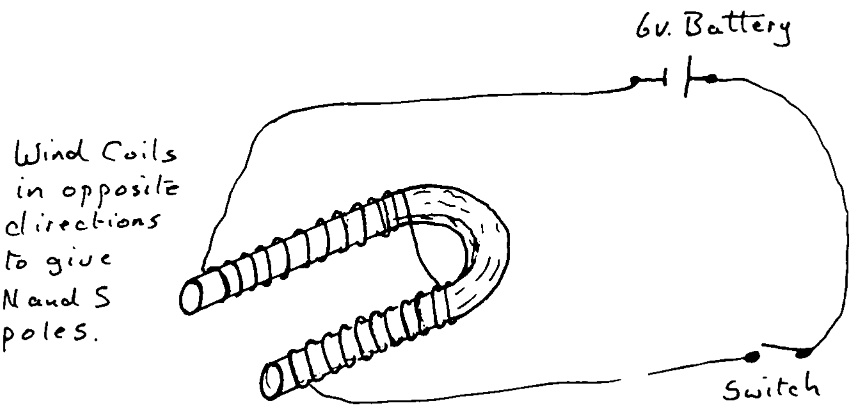
almost horizontal whilst to lift heavy loads the jib must be getting closer to the vertical position. For the older age range of pupils this could lead on to an introduction to Moments. The pupils may observe that to lift heavier loads a stronger magnet is required which can lead on to an electric circuits project to investigate the relationship between voltage, current, and resistance, and also energy and power.











The basic toy was submitted by ICASE and was included in a publication *A Collection of Apparatus Assignments* by TSM 104 Course Participants, RECSAM, Glugor, Malaysia.

The Change of the Topography

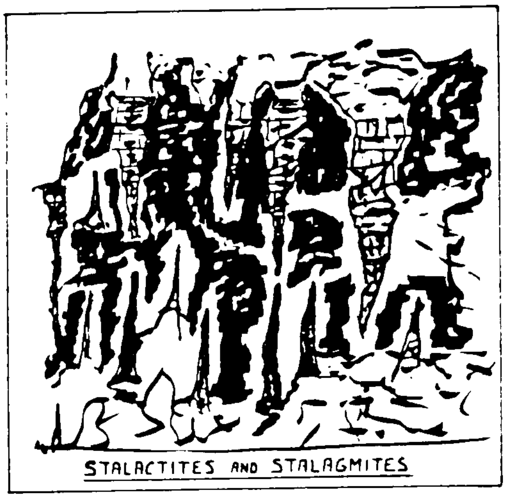
This game is described as a Concentration Game and was submitted by South Korea as one of three science activities which were developed and trial tested in schools. The material developed consisted of a Teacher's Manual, cause cards, picture cards, and name cards.(Some examples are shown below)

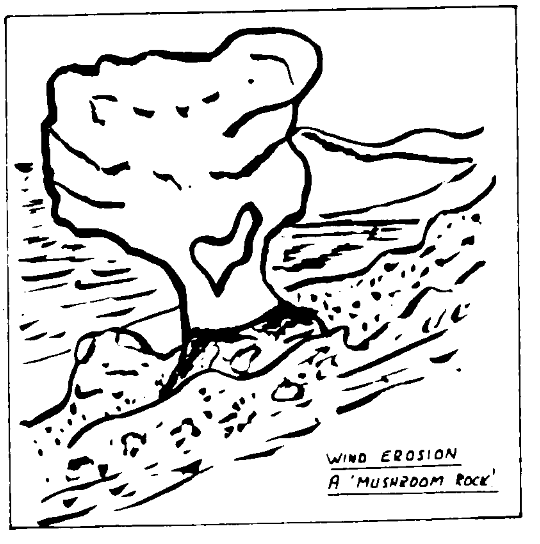
Suitable for an age range of 12 to 13 years.

The game is designed to have students understand that the topography is influenced by air, water, volcano and other natural phenomena. As students participate in the game, they will be able to discriminate different shapes of topography and point out the causes of particular topography. The specific objectives are stated as After playing the concentration game, students will be able to name the particular type of topography as shown in the pictures; match the causes and resulting topography; describe the causes of certain types of topography.

Educational Concept/Skills to be developed

Concepts of topographical change; function of wind, water, ground water, sea water, volcano and glacier to the change of topography; and the format of V valley, waterfall, meandering river, delta, limestone cave, stalactite, stalagmite, stone pillar, U valley, fiord, triangulate stone, sandhill, seashore, cliff and caldera.





Game1.

Group size. Two teams of S to 10 students each (if the class is large the game can be repeated up to 3 rounds with six different teams). If the team size of 10 students is so large that many students are unable to have a go, since the game is over to quickly, make a team of S students and have the remainder play in Game 2.

How to play

i. Each team selects one student each to decide, by the flip of a coin, which team goes first.
ii. Each team selects one student each to act as scorer for the opposing team. Scores being marked on the chalkboard.
iii. The cause cards are spread out, face down, on the desk. The picture cards are also placed, face down on the desk but separated from the cause cards.
iv. The first player turns up one of each of the cause and picture cards attempting to match the cause with the topography picture.(the students should try to remember the location of cards being turned over before their own go).
v. If the cards turned up by the player do not match the opposing team take their turn. Before doing so, the unsuccessful player should return the cards to the desk, face down, after all players have seen them.
vi. When the cards match at the first try the player should leave the picture card face up and place the cause card face down, and play once more. If the player again turns up matching cards the above is repeated except the player passes the turn to the opposing team. No player can have more than two consecutive goes.
vi. If a player matches the cards right at the first try, he gets 5 points, and has a second turn. If a player again gets a matched pair at the second turn he gets 10 points(and the turn goes to the opposing team).
vii. If a player does not match the cards he does not get any points.
viii. A player's score is added to the total team score.
ix. When all picture cards are turned face up, the game is over.
x. The team that scored the highest number of points is the winner.

Game 2.

All procedures and rules are the same as for Game 1. except that name cards instead of picture cards are used.

Points for the teacher to consider

Rewards. The individual student's reward is a doubling of the points when a second try is successful since this is a bonus to help his team win.

A reward for the winning team is the chance to play another round against a different team. (The losing team should also be given the chance to play again and improve on their score).

When considering further play consideration should be given to such factors as have all students been able to take part; is the interest level high and students are anxious to play and win; are students getting bored.

By careful observation of the individual student's performance a non-formal . assessment of performance could be made and remedial action taken later where necessary.

The expected effects of using the games are A reduction of the instructional time;
A heightening of student's interest level;
Improved retention and transfer of learning.

WATERFALL	STALAGMITE
MEANDERING RIVER	DELTA
V VALLEY	LIMESTONE CAVE
STONEPILLAR	STALACTITE
SEASHORE CLIFF	SANDHILL
U VALLEY	TRIANGULATE STONE
CALDERA	FIORD

WIND	WATER
GROUND WATER	SEA WATER
VOLCANO	GLACIER

A GORGE.

As a conclusion to this publication some comments from the evaluation of the final game are worthy of consideration.

'Teachers were somewhat anxious and students were too eager to do well that games usually end to quickly.'

'Teachers were not well accustomed to do the games during the class hour and were uneasy about the entire procedure because the vice-principal is deeply involved and watched the process.'

'Students were not used to the game environment and they were trying too hard to remember every - thing even though they enjoyed the game'

'Teacher of the control group told his students that they must do well on the final exam because they are going to be compared with other class.'

Don't be disheartened! Remember, what the children ask for is